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MATERIAL AND ETHICAL PROGRESS

THE need for restoring the balance between man's material and his spiritual advance has been a recurring theme in scientific discussion, and in the writings of such men as Louis Mumford and K. Mannheim, since the memorable presidential address given by General Smuts at the centenary meeting of the British Association. Papers contributed by Prof. B. Dobrée, and by Dr. D. M. Emmet, Prof. T. W. Manson and S. Hird at two discussion groups on "Science, the Universities and the Modern Crisis" arranged by the Manchester Literary and Philosophical Society in 1944–45 are specific examples of this trend of thought. More recently, Sir Henry Tizard struck the same note as a minor theme in his own presidential address at Brighton, and Lord Samuel's evening discourse on "Science and Philosophy" called imperatively to science to join philosophy and religion in promoting a synthesis which would be adequate to redeem this age from past calamities and rescue it from present dangers.

The approach to this problem of balance or of synthesis has been made from various sides: from that of education, as in the Manchester discussions; of philosophy, as with General Smuts and Lord Samuel; and of religion, as in an important section of the recent report of the Lambeth Conference. It has also been approached from that of human relationships. The importance of such relationships in industry and in the State give special interest to the study of the critical problems in human relationships to-day at the "Present Question Conference" held in Birmingham last year. The addresses and discussions at that Conference have recently been published*. They follow the discussion at an earlier conference of the question "Is the present chaos caused by lack of scientific planning or by failure to recognize the reality of spirit?" It is to be hoped that addresses and discussions at the Conference last August on the problem of leadership in a free society, which are in sequence with those contained in the present pamphlet, will likewise be available at an early date.

In introducing the three lectures, by Dr. J. H. Oldham, Mr. Herbert Read and Mr. G. W. Knight, which, with the subsequent discussions, comprise this pamphlet, the editor maintains that we are concerned less with a problem to be solved than with an idea to be experienced, and that the creative power in the soul of man which in a mechanical age makes it possible for him to become a person is the same principle that in earlier ages has given life and order to society. Dr. Oldham, pointing out that the answer to the question regarding human relations depends on one fundamental belief about the essential nature of man, proceeds to a penetrating analysis of the implications of a free and tolerant society and its maintenance in the face of threatened domination by impersonal forces and central direction by 'social

* Question: a Journal. Vol. 1, No. 1, July 1948. The Critical Problem in Human Relationships Today. By G. Wilson Knight, Herbert Read and Dr. J. H. Oldham. Pp. 87. (London: Hammond, Hammond and Co., Ltd.) 2*s.* 6*d.* net.

engineers' or planners. In the modern period of history men have come more and more to think of themselves as individuals in a world which it is man's primary business to understand, explore and subordinate to his own purposes. We have now to ask whether this is the only attitude, or even the most important attitude, of man to his world.

Dr. Oldham suggests that this is the point on which some of the most creative minds to-day are working; and he develops the conception of Martin Buber and Nikolai Berdyaev, implicit, perhaps, too in the writings of Jacques Maritain, that there is a fundamental difference in our relations to things and our relations to persons. He acknowledges the influence of the German philosopher Eberhard Grisebach on his thinking, and emphasizes the implications for social and political life of this truth: that man is fundamentally a person and that he finds his satisfaction and happiness, not in solitariness but only in a living relationship with other persons. The critical issue is whether our present preoccupation with things is to be made instrumental to the growth of true community, or whether we are going to be increasingly subject to the domination of things. Both individualism and collectivism are, in fact, a complete denial both of the person and of community.

The task of restoring the balance of human life, which is immensely complicated by the technical developments of our civilization, involves learning or re-learning personal relationships in the family, the neighbourhood and the workshop at the level of our own personal attitude or behaviour. Next, we have to develop ways in which, by the formation of human associations, persons educate and discipline themselves, through relations of mutual responsibility and mutual obligation towards one another. Only in these small groups are full and lasting relations between persons possible. In spite of Dubreuil's experiments, even in industry the implications of the Western Electric investigations associated with the name of Prof. Elton Mayo are not widely appreciated. The human problems of an industrial civilization are, as he pointed out in his last book, the key to industrial relations and to the development by man of the skill to live with his fellows as persons in genuine human relationship.

Beyond this we have to provide opportunities for people to learn in co-operation with others those wider aspects of citizenship which concern our general life. Here alone can we develop the real core of resistance to totalitarianism. The development of a hierarchy of groups—families, towns, counties, regions, trade unions, universities—with healthy and vigorous lives of their own, is the surest way of resisting effectively the encroachments of central authority and thus maintaining a free society. The preservation, not merely of freedom of the human spirit, but also of those other freedoms, of utterance and investigation, upon which that spirit is nourished, ultimately depends upon the existence of such groups. Moreover, they offer, too, an invaluable means of reaching that decision which may have to be made as to which in practice are the vital freedoms to preserve and which must be surrendered to preserve the others. Local associations with a strong, healthy, independent life of their own are the only means of securing a body of citizens alert to detect and protect those points at which freedom is threatened and who will not be deceived by the casuistry of totalitarianism into surrendering those freedoms which are essential to the growth of the human spirit. The pattern of Dr. Oldham's thought can be traced in Lord Lindsay's "Religion, Science and Society in the Modern World", as well as in Prof. Elton Mayo's and Dr. K. Mannheim's books.

Mr. Read's paper, on "The Moral Principle in Education", has for its theme that in education we must give priority to all forms of æsthetic activity, because in the making of beautiful things the emotions crystallize into what are in effect social patterns, the patterns assumed by human relationships. Mr. Knight gives a fresh interpretation of the positive aspects of Nietzsche. Both offer a profound and more constructive contribution than any of the miscellaneous papers in "Civilisation"*, a collection of essays by J. Prévost, L. de Broglie, A. J. Toynbee, H. Nicholson, R. Speaght, M. de Corte, Aldous Huxley and others, through which runs the *leit motif* of a dying civilization—a pessimism almost entirely unrelieved by any birth-pangs of a new age, or even the hope of a new civilization.

It is true that here also it is recognized that men need to renew their belief in the eternal values, and that civilization must have spiritual foundations; but however searching the criticism of the weaknesses of civilization, it is pervaded by a spirit of defeatism rather than by any firm confidence that man will triumph over the new barbarism. The brilliance and confidence that mark the no less searching analysis of Charles Mayer in "L'Homme ne vaut que par le progrès"† are absent. Devastating and disconcerting as is Charles Mayer in some of the criticisms of this age which he puts into the dialogue between the Parisian citizen Durand and the philosopher-scientist Neon, there is unwavering faith in the ability of man's spirit to transcend and transform his material environment. As André Maurois remarks in his preface, Mayer's central theme may be summarized: "Il faut cultiver notre esprit".

In upholding the idea of progress, in which so many in this generation have lost faith, Mayer ranges over a wide field and is often stimulating and suggestive in his comments on such diverse themes as freedom, science and morality, feminism, unemployment, education, capitalism, private property, medical practice, scientific research and social institutions. He writes with a refreshing forthrightness, and those who are moved to contest any of the scientific principles of a progressive materialism or the principles of a progressive conception of the individual and of society with which he concludes the first two parts of his book, can scarcely fail to appreciate the lucidity and liveliness of his argument. It is a book which carries a message of hope and, materialist as he is,

* Civilisation. Edited by F. Berge. Chemins du Monde, No. 1. (Paris: Éditions de Clermont, 1947.) 100 francs.

† L'Homme ne vaut que par le progrès. Par Dr. Charles Mayer. Pp. 401. (New York: Éditions de la Maison française, Inc., 1945.) n.p.

Mayer reaches, but for different reasons, a belief in the same values as those put forward in the Lambeth Conference report. The social order is indeed, as the Encyclical Letter puts it, all the time being made by the thoughts men think, the loyalties they honour and the deeds they do or leave undone. The world is adrift because it is defying the moral law and repudiating that divine authority which is the basis first of justice and then of peace.

Here then is a fresh challenge to seek out at all levels those new forms of social organisation which are necessitated by the power for the better ordering of the world which the new discoveries and technical inventions of our time have given us. The very condition of survival is the transcendence of outworn experiments in the way of living and social institutions. We have to concentrate anew man's moral and spiritual capacities to employ the material instruments as servants of new possibilities for human well-being. Free institutions cannot be safeguarded solely on a secular basis; and democracy demands for its working those qualities of self-restrained discipline such as have flowered in the training provided by Christian fellowship; while, as the Lambeth report wisely reminds us, we must not allow the State to disregard or throw away the experience and goodwill which are found in voluntary social service.

The diverse issues raised in these three publications never obscure the challenge which they offer to fundamental thought regarding the moral and spiritual values on which alone the rebuilding of Europe and our own recovery can be based, and through which we must find the means to avert the menace which Russian communism offers to the human spirit. With that challenge to thought, Mayer and Oldham at least point out ways in which we can begin to work out new means, alike in industry and in society as a whole, of safeguarding the freedom of the human spirit and establishing the human relationships which will remove the strain and stress handicapping our effort at even economic recovery. These are issues which touch the scientific man himself very closely, for they form part both of the strategy and the tactics by which men must secure the conditions in which the human spirit can express itself freely and creatively in science and art and human affairs. The area within which that freedom is possible is steadily being narrowed. Independently of the merits or demerits of particular proposals for the nationalization of industry, the passing of increasingly large areas of economic life under State control has repercussions on human freedom which ought to be weighed before and not after those measures are implemented.

Here, indeed, is a practical issue to which not only men of science but also professional associations, trade unions, the churches, the universities and other groups should address themselves as a matter of urgency. These publications give a valuable lead; but there is much to be done before we can elaborate either the strategy or the tactics of freedom and apply them successfully to particular issues of the day. Dr. C. E. Raven, vice-chancellor of the University of Cambridge, remarked recently that creative freedom is the governing concept of university life. It is a vital element in the life of any free community. But any such community that hopes to survive to-day must not think of freedom as a passive state in which we can do as much or as little as we like. As the Queen remarked at Cambridge in reference to Dr. Raven's words, freedom is something more—a force, a dynamic organism which enlivens everything it touches. It is a culture of the mind produced and nourished by the processes of education. Not the least responsibility of men of science to-day, individually and collectively, is to join with all those forces which are seeking to safeguard the free society, and to renew the moral and spiritual forces upon which the creative power of Western civilization depends.

DR. ROBERT BROOM: NATURALIST

Special Publication of the Royal Society of South Africa

Robert Broom Commemorative Volume. Edited on behalf of the Society and the Bernard Price Foundation of the University of the Witwatersrand by Alex. L. du Toit. Pp. v+257. (Cape Town: Royal Society of South Africa, 1948.) 22*s*.

THE Royal Society of South Africa has honoured Dr. Robert Broom, of the Transvaal Museum, Pretoria, on the occasion of his eightieth birthday, by publishing a volume of papers by many men on subjects to our understanding of which he has so greatly contributed. After a delightful introduction by General Smuts, we are given a short biography and some personal reminiscences by D. A. Roberts; then follow a number of articles dealing with fossil reptiles, the field of study within which so much of Broom's work has lain.

Beginning with accounts of the structure of the mammal-like reptiles of South Africa, designed to elucidate the mode of origin of mammals, Broom passed on to earlier forms, which include their ancestors, and in so doing revolutionized our ideas of phylogeny, and gave the clue to our present classification. This series ends with a most valuable discussion of the climatic setting of the Karroo reptiles by Mr. du Toit.

Then follows a series on the fossil men and man-like apes of Africa, works which owe their existence to the early recognition by Broom of the rightness of Dart's views about the position in the anthropoids of the young skull of *Australopithecus*.

Inspired by this find in a cave in the Transvaal, Broom examined very many caves and by dogged persistence found those marvellous fossils which he has so accurately interpreted as members of a new family of the Hominidæ, giant apes, adapted to life in semi-arid lands, walking erect like men, with man-like teeth, but with an ape's brain. The discovery and description of these animals is beyond all question the most important contribution to our knowledge of the primates, other than man himself, which has been made for a hundred years or more.

But Broom has also made additions of fundamental importance to our understanding of the

human races which have in the past inhabited South Africa. Here again he gave the impetus to the active interest in this subject in South African universities, shown by several papers in the commemorative volume, in which the authors, whether they agree or differ, are at one in starting their arguments from Broom's fundamental works.

Broom's first interest was in embryology, and it is appropriate that the volume should include papers in this field.

Broom has always held that taxonomy in the restricted sense of specific discrimination is not only valuable and necessary, but also demands from the man who does it altogether exceptional judgment. Throughout his working life, Broom has described new species—hundreds of them in fact—and it is pleasant to find new species here described.

The volume contains—unusually but most fortunately—a paper by Broom himself in which is described a whole series of small Theriodonts of very great interest.

A bibliography of Broom's published scientific work which ends the volume includes a list of 402 papers, beginning in 1885, when he was nineteen years old, with a paper on the volume of mixed liquids, in the *Proceedings of the Royal Society of Edinburgh*, and continuing until to-day, so that it needs addition.

Broom's life-work is unparalleled by that of anyone now living. In its range, in its mere mass, it recalls the great Victorians, Owen, Huxley and Lankester; and in its quality, in the extent to which modern work in many fields can be traced back to it, and in the verve and vigour which it shows, it is indeed worthy to be compared with that of these great men of the past. D. M. S. WATSON

THE ANATOMY OF CO-OPERATION

Managers, Men and Morale

By Wilfred B. D. Brown and Winifred Raphael. Pp. vii+163. (London: Macdonald and Evans, 1948.) 10*s*. 6*d*. net.

PERHAPS the most outstanding event in the industrial story of Britain in the 1940's is the advancement in the technique of co-operation between master and man—or, between managers and employees, to put it into its modern wording. Admittedly that story has not everywhere been characterized by undisturbed harmony; but as to the extent of the progress achieved, and its soundness in fact, there can be little room for doubt. In the main, the achievement has been in the realm of formal relations between organised parties, that is, procedures for negotiation and continual consultation between representatives: employers' federations and trade unions on an industry basis, or managers and shop stewards at the individual factory level. Yet there has been an advance, too, in the more informal pattern of consultation that is inherent in the everyday contact of manager and supervisor with the men and women under their jurisdiction—an advance measured chiefly in widespread recognition of this factor as an element in executive responsibility. This fact of employee relationships is, many authorities are coming to agree, of greater significance in the conduct of industry than the formalized pattern characterized by a meeting of 'sides' across a table, more often glaring than smiling, and more often interested in their own respective good rather than in the pursuit of a common task.

It is with this subtler yet more essential form of co-operation that the present book is concerned. "Our theme has been that the practice of management should be based on certain fundamental hypotheses concerning the reactions of the human being to his social environment. . . . We have been organising the production of goods and services for two hundred years with ever increasing success if we measure our achievements in terms of production; but with a most noticeable lack of success if we measure in terms of the effect of our organisation on those engaged in the process of production. Indeed, it almost looks as if the degree of co-operation, pride in work and happiness, arising out of the association of human beings in industry, is less to-day than it has ever been. People have more material possessions to-day, but less psychological satisfaction from their association with the results of our organising."

The framework of the book has been erected to provide for a full study of the fundamentals of co-operation at all levels—the board of directors, the senior executives, the specialist managers and staff, the supervisors and the operatives themselves. The authors frankly disclaim any pretence to a 'textbook', and the chapters devoted to each of these manager-levels are in no sense a review of the detailed practices of management. They are, instead, a scrutiny of the means of creating and maintaining a sense of common task; they describe the anatomy of co-operation, not just the skeleton, but the nervous system as well, and their illustrations draw chiefly on the nervous system in action. Witness this momentous paragraph from the introductory chapter: "If we attempt to achieve efficiency in the hope that happiness will follow, we are usually putting the cart before the horse. Nobody can work efficiently while suffering a sense of injustice, grievance or frustration. Good work cannot be turned out under such conditions. It is clear, therefore, that the task of the manager is to achieve efficiency *through* happiness. It is useless to look at the group we command and say to ourselves: 'I have done everything that a man can reasonably be expected to do to make these people happy, and consequently they should be happy. Now I can forget that issue and concentrate on efficiency.' A manager must continually observe his subordinates and courageously face the facts. If they are not happy, it is useless to escape from the responsibility which that fact imposes upon him by assuring himself that they ought to be happy. His job is to find out why they are dissatisfied; then to do everything possible to eliminate the causes of their dissatisfaction."

To say that this book will be misunderstood and misinterpreted is to pay a compliment to the far-sighted approach of its authors. One reader has commented—and many may sympathize with him—on the curtailment of the authority of management that their teaching represents, as though replacing woolliness of discussion for the firmness of decision. But such readers have not grasped the essential principles of the study or the real implications of what the authors are saying. A little more unkindly, one could say that they have overlooked a fairly lucid passage in Chapter 7: "We are not trying to suggest in any way that authority should be shared. The final say must rest with the executive, who

bears the ultimate responsibility. But Mary Parker Follett was abundantly right when she talked about 'de-personalizing orders'. An order must be seen to be the 'law of the situation' if it is to be readily accepted. It will create resentment if it appears to be the whim of the manager. The object of discussing a problem with a group is to find out what the situation is, rather than to put upon them the responsibility of making a decision." There is, in fact, quite a possibility that some readers will squirm at the strikingly autocratic tone in which it is suggested (in Chapter 4) that a managing director might introduce functional experts into his firm.

There are a lot of things that could be said about this book—mostly good things!—and there are a lot of points that could very usefully be taken up for examination or emphasis. In the compass of a short review, however, further comment is perhaps best confined to a selection of the more fundamental issues. The chapter on "The Outside Consultant" is an unusual feature in a serious book on management; this is an excellent chapter, objective and balanced in its appraisal of the part that the expert consultant can play in the advancement of the practice of management. It has a special relevance to immediately contemporary conditions and is a welcome recognition of the value of the soundly established professional consultant in a new domain.

Chapter 7, "Attitudes in Industry", is again a new feature, describing recently developed techniques for assessing public opinion within a factory on matters that reflect the outlook and competence of management and so are pointers to the level of morale. A kind of 'Gallup poll' of an industrial organisation would be a popular description of the process, though the techniques described are of far less importance than the recognition, which they imply, of influence that the impact of management can exert on the human tone of the organisation. In one sense, this chapter points to a method of diagnosis or study of the anatomy of co-operation, and underlines the authors' own conception of the scientific method in industrial relations—"Management," they say elsewhere in the book, "is a problem of human relations. By definition the manager attains his objective through the government of others. His principal task is therefore that of establishing good relations with those others, both his subordinates and his seniors. If management is to be scientific, it must call upon the knowledge and experience of those who are expert in group relations." This is different only in wording from F. W. Taylor's plea that among the factors in the industrial situation which should be made the subject of systematic analytical study are "the motives that influence men"—a thought which puts the notion of scientific management in a setting very different from that habitually attributed to it.

From scientific method to the establishment of principles is in logical sequence, and so it is fitting that the concluding chapter should refer to targets "embodying certain principles of organisation". Regrettably, the authors have allowed themselves to be deluded into reproducing "principles [which] are to be read as a description of what is actually done in one organisation"—a conception that is difficult to square with the customary connotation of 'principle'. But if the title 'target', as used in the chapter heading, is given to these lists they undoubtedly stand as valuable prescriptions for the betterment of management.

If there is any serious criticism of this study, it is its unmitigated 'producer interest'; its whole content is aimed at the well-being of those whose lot in life casts them in the processes of manufacturing. Admittedly, the book is not meant to be a study of economics; but there are many points at which certain assumptions have obviously been made as to the purposes of industrial activities and their relative role in the scale of social values. Those assumptions have clearly been made in terms of the prior interests of the producers—of the workers and managers engaged in manufacturing industry. Specific evidence is difficult to cite, the only clear case being the relegation of consumer interests to the fifth place out of six items to which surplus revenue should be devoted (p. 155).

The existence of purchasers is thinly recognized in the first principle set out as a basis on which a worker can identify himself with the purposes of an industrial community (p. 93), though economists (as well as citizens who have lived through the years 1945–48) would argue that only a price mechanism could determine what manufactures are of no value to consumers because they are either 'a fake' or 'useless' or 'gimcrack'. Consumers—who are really just the workers and managers without their overalls—have unaccountable bases of preference!

It is high time that the professional manager and the technologist recall to mind that the primary purpose of the economic system, of all industrial activities, is the provision of the goods and services that the consumer wants. This can very safely be stated as principle No. 1. E. F. L. Brech

TRAINING THE WORKER

Principles and Practices of Vocational Education

By Prof. Arthur B. Mays. (McGraw-Hill Series in Education.) Pp. viii+303. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 21*s*.

IT is becoming more and more clear to most people connected with British industry that the way out of the present economic crisis will not be by the introduction of new machines. For some time to come industry has to make do with the bulk of its present capital equipment, and, now that the labour force is stretched almost to its maximum, any real increase in production can only come by a change in methods. This will involve considerable modification of the attitudes of many managers and workers, and to-day various agencies are seeking ways whereby time-honoured behaviour patterns can be changed swiftly and efficiently. Among the ways which have been and are being increasingly used to add to overall efficiency is what industry has come to call 'education and training'. Simple as this may sound, it is surprising that, even in 'enlightened' firms, the process of providing a man with specific training to do a job is often regarded as something which hinders rather than helps production. Engineers, of course, have to be trained; so have chemists. They may even need a four-year preliminary course before their training starts. But the semi-skilled and unskilled workers can pick up their jobs by being put alongside Joe and Tom. In the Services men are given their training before being assigned to a unit; in industry many men and women have to learn their jobs by picking up all that cannot be concealed from them.

It is therefore refreshing to pick up a book in which a professor of industrial education indicates not only methods of training different grades of workers, but also carefully examines principles upon which vocational education should be based. The more these principles and practices are disseminated, the more quickly will employers and employees realize that 'education and training' can do much to promote the well-being of workers and, concurrently, industrial efficiency.

Much of the book is devoted to education for the more humble jobs, although one section is given over to a discussion on vocational education at the university-level and another to the preparation of teachers. Probably the most important chapter is that in which the author considers the significance of vocational education in democracy and its relation to industrial productivity. Starting with the late Theodore Parker's dictum that "democracy meant not 'I am as good as you are' but 'you are as good as I am' ", Prof. A. B. Mays emphasizes that modern ideals of democracy call for equality of opportunities for all levels, classes and individuals. "Men to-day require not only that their preachers and lawyers be given opportunity for proper training but that their cooks and chauffeurs also find such opportunities. Not only the engineer, the doctor and the architect but the factory workers, the nurse, and the carpenter must be given a fair chance for vocational education." Nor does the factory worker mean just the skilled fitter, turner or other craftsman. Under the handicraft system of the pre-industrial revolution era these men were mainly responsible for production. To-day, they are mainly concerned with the maintenance of equipment, and most productive processes are performed by unskilled and semi-skilled workers. In industrial training programmes all grades of workers should be included, and Mays makes suggestions for each grade which are similar to those already in practice in a small number of firms in Britain.

It is significant that Mays advocates drastic changes in existing attitudes to the selection, training and status of foremen, and suggests that, if the teaching function of the factory foreman were to become more widely recognized, many of the problems of providing adequate training for unskilled and semi-skilled workers would solve themselves. Much of the chapters on organisation and administration would not be appropriate to British education or industry, but even here Mays' principles are sound, and reinforce the opinion that this is an important and, for British readers, a well-timed book.

T. H. Hawkins

A NEW THEORY OF LEAF FORMATION

La théorie des hélices foliaires multiples

Fondements d'une théorie phyllotaxique nouvelle. Par Prof. Lucien Plantefol. Pp. 154. (Paris: Masson et Cie., 1948.) 400 francs.

IN this book, which has appeared in parts in recent numbers of the *Annales des sciences naturelles botanique*, the author proposes a new theory of leaf formation, after rejecting as erroneous nearly all previous work. He considers that the positions in which leaves arise depend on a number of generating centres (*centres génératrices*) in the stem apex above them, which form leaves successively along a number of foliar helices winding in *one* direction around the apex or axis. But since these generating centres might get out of time one with another, he also postulates an organising centre (*organisateur*) in the apex to control them. Thus the organising centre is like a conductor, and the generating centres are the players which follow its beat. All these must be within the stem apex, which may be only 150 μ across, or even less.

But what are these foliar helices along which the generating centres act? It is well known that in sections of spiral buds, and less easily on some mature organs, there can be seen two sets of leaf spirals or helices, the parastichies, winding in opposite directions, and that the numbers of these two sets are commonly successive numbers of the Fibonacci series 1, 2, 3, 5, 8, etc. The helices which the author intends are some of these; but which they are and on what principle he selects them is a more difficult question. For he selects only those winding in one direction, and claims that they are of varying numbers in monocotyledons, but usually only two in dicotyledons. The only grounds for choosing two in dicotyledons seem to the reviewer to be that the number two occurs in both of the lowest and commonest Fibonacci systems, those with parastichies $1 + 2$ and $2 + 3$, as well as in the decussate system $2 + 2$, and that higher Fibonacci systems are reached by passing through the lowest Fibonacci systems in development.

The theory has something in common with that of Church (1904), whom the author does not mention. For Church supposed that the apex forms leaves at the *intersections* of spiral paths, forming continuations into it of the two observed sets of opposite parastichies. He thus did not need to postulate any central organising centre to regularize matters during constant phyllotaxis, since the uniform growth of the apex would suffice for that. For this reason and also because it is based on *all* the parastichies observed, Church's theory seems much preferable for those who favour any theory of this kind at all.

Although the author seeks to account for the sequences and positions in which leaves are formed at the apex, he offers no evidence of what those positions actually are, his whole book containing no illustration of an apex or bud section. Instead he tries to infer from observations on mature organs in what positions the leaves must have been formed. But such inferences may be quite wrong, and in particular in certain lilies which the author discusses he clearly does not know what actually are those positions of leaf formation which he seeks to explain. He also seems to think that all previous workers have supposed that there was some causal significance in the genetic spiral, which is the spiral drawn through the leaves in their order of development. But this was not the opinion of Church, nor of those workers who, following Hofmeister, believed that the positions in which leaves arise are somehow determined by the existing leaves just below them. The evidence in favour of this last opinion is scarcely discussed. With one point the reviewer agrees: that the divergence angles between the centres of successive leaves in spiral phyllotaxis are not simple fractions of 360°. One may confidently expect that if the author, who has won distinction in plant physiology, will study shoot apices rather than mature organs, he will contribute something of greater value to the theory of leaf formation.

MAGNETISM

SECTION A (Mathematics and Physics) of the British Association conducted a symposium on magnetism at Brighton on September 13, with Sir Lawrence Bragg, president of the Section, presiding over the meeting. Three papers were presented; the first two dealt with materials and the last with a problem in metal physics. The title of the first, by D. A. Oliver, was "Recent Advances in Anisotropic Permanent Magnet Alloys"; that of the second, by N. F. Astbury, was "Anisotropic Silicon Iron"; while the concluding paper, by D. Shoenberg, was entitled "Magnetic Properties of Superconductors". A discussion followed the first two papers and the last one.

Mr. Oliver (William Jessop and Sons, Ltd.) recalled the discovery in 1938 of the effect of inducing anisotropic permanent magnet properties into a cube of 'Alnico' by cooling from 1,200° C. in a strong magnetic field[1]. The subsequent developments by Dutch[2,3] and British[4] workers gave rise to the 'Ticonal' and 'Alcomax' series of alloys which contain more than twenty per cent of cobalt. The successive advances were outlined and special mention was made of the work of Tetley, Edwards and Hoselitz and of the staff of the Philips research laboratories at Eindhoven. Axial and planar[5] anisotropy were distinguished; for the usual, or axial, type of anisotropy it was noted that $(BH)_{max}$ products of 5 millions (gauss, oersted) are now approached commercially (and occasionally exceeded in the laboratory) when the properties are measured in the preferred direction. This energy value was compared with 1·6 millions for the older (isotropic) 'Alnico'[6]. Typical magnetic constants for 'Alcomax II' are remanence (B_r) 12,500 gauss, coercive force (H_c) 550 oersted, and $(BH)_{max}$ $4{\cdot}3 \times 10^6$. (The maximum stored magnetic energy in ergs per c.c. is equal to $(BH)_{max}/8\pi$.) Investigations have recently been conducted along the lines of eliminating chemical impurities, and certain improvements have resulted. The latest research by the Permanent Magnet Association, in collaboration with the British Electrical and Allied Industries Research Association, has shown that niobium (columbium) additions are advantageous for increasing coercivity[7]. With intensive development by the Permanent Magnet Association a new experimental alloy has resulted having tentative constants as follows: (B_r) 11,200 gauss, (H_c) 750 oersted, $(BH)_{max}$ 4·3 millions. This new material may prove especially advantageous when space considerations limit, in a given piece of equipment, the maximum permissible length of magnet part. Mention was also made of the recent (unpublished) researches by Dr. A. J. Bradley on the iron–nickel–aluminium system. These are throwing much light on the actual structures associated with optimum magnetic properties. The earlier mechanism put forward by Bradley and Taylor[8] in 1938 has been confirmed and extended. Two body-centred cubic phases are the principal ones; the iron-rich being disordered, the nickel–aluminium-rich being ordered after prolonged annealing at 850° C.

Alloys in an optimum magnetic condition show little definition under the microscope when polished and etched (Fig. 1). However, following prolonged annealing at 850° C. for sixteen days and after careful polishing and etching, a clear structure is visible at a high magnification (× 2,000, Fig. 2). Furthermore, evidence has been obtained for cubic mozaic blocks having an edge length of $2{\cdot}5 \times 10^{-5}$ cm. or simple multiples of this dimension. Micro-segregation is present in so far as the nickel–aluminium-rich phase concentrates near the centre of each mozaic block, while the iron-rich phase is found on the exterior. These blocks are subject to magneto-striction biasing effects when the alloy is heat-treated by controlled cooling in a strong magnetic field, and final atomic rearrangements during tempering may be expected to occur in their vicinity. Single domain characteristics may be ascribed to each elementary mozaic block, and the coercivity effects can largely be explained on the lines of the recent theory put forward by Stoner and Wohlfarth[9]. It is, however, important to recall that the segregation processes are incomplete when the best permanent magnet properties have been established. Then the predominantly

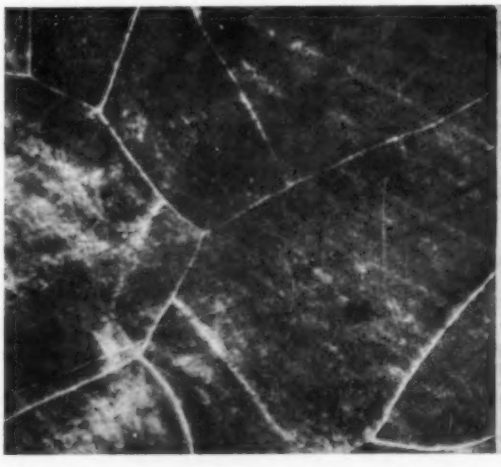

Fig. 1. Typical photomicrograph (× 50) of Fe_2NiAl in optimum magnetic condition. Note poor details after polishing and etching; no improvement with increased magnification. (After Bradley)

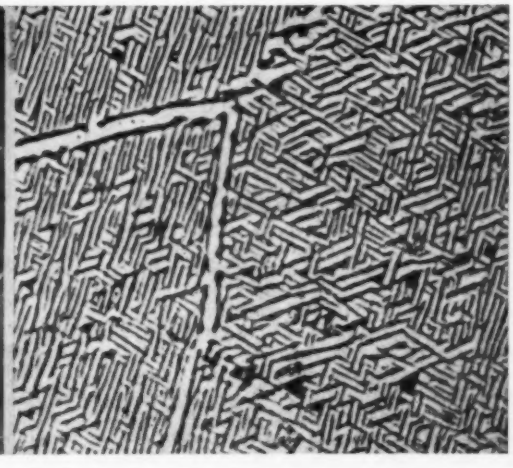

Fig. 2. Photomicrograph of alloy near composition Fe_2NiAl after annealing for 16 days at 850° C. Transformation point, 950° C. Polished and etched; magnification, × 2,000. Black: iron-rich magnetic; white: NiAl-rich non-magnetic. (After Bradley)

Fig. 3. Comparison of hysteresis losses for oriented and normal hot-rolled silicon–iron sheet. (B_{max} = 10,000 gauss; f = 50 c./sec.) Inner loop: 'Crystalloy' (oriented); outer loop: 'Stalloy'. (After Astbury)

iron-rich 'islands' can be regarded as subjected to compressive forces induced by the distribution of the largely non-magnetic nickel–aluminium-rich phase. The explanation of all the phenomena present is still imperfect but much progress has been made.

Mr. Astbury (Joseph Sankey and Sons, Ltd.) outlined the many important matters of detail in the achievement of highly oriented, cold-rolled 3 per cent silicon–iron electrical sheet-steel having low overall energy losses when subjected to alternating magnetization. The process, originally associated with the name of Goss, involves a sequence of cold reduction and intermediate heat-treatment which results in a well-defined rolling texture. These operations are followed by a high-temperature anneal, when the rolling texture, predominantly [110] (001), changes on recrystallization to [100] (011), which is similar to a single crystal having the magnetically favourable [100] direction along the rolling direction and the diagonal (011) plane in the strip surface[10]. Under the best conditions, losses of 0·28 watts/lb. at 50 cycles per second and an induction of 10,000 gauss have been obtained, associated with a maximum A.C. permeability of 22,000. The reduced losses and higher permeabilities are evident from the curves of Fig. 3, which compare at an induction of 10,000 gauss the normal hot-rolled silicon sheet ('Stalloy') with the new oriented material. Losses have been halved, and the initial and maximum permeabilities have been greatly increased.

The texture of the finished strip being all-important, four methods for its determination were outlined: (1) X-ray crystallographic methods, (2) optical methods (using reflexions from crystallographic etch pits), (3) strain anisotropy methods, and (4) magnetic methods. Typical results were shown, together with the final derived pole-figures. Finally, this able survey was concluded with a description of the best methods for arranging the lay-out and joints of practical magnetic circuits using anisotropic sheet materials so as to give maximum effective permeability and minimum overall losses.

In the discussion which followed, Dr. K. Hoselitz (Permanent Magnet Association) stated that changes in magnetization occurred by rotation and by boundary movements. In a permanent magnet material it was necessary to inhibit boundary movements, while in a soft magnetic material they should be encouraged; the presence of strain and non-magnetic inclusions prevented boundary movements. In the calculation of coercive force when rotations only are considered, high values were obtained; suggestions were made for refining the calculations. Prof. L. F. Bates (University of Nottingham) expressed his interest in high-coercivity alloys and said so much more could be explained if domain vectors were assumed to rotate only through angles not exceeding 90°. They had studied recently[11] the dependence of the value of Young's modulus (E) upon magnetization for the pure metals, iron, nickel and cobalt and for the permanent magnet alloy 'Alnico'. For nickel, under certain conditions, the change in E was 7 per cent; for 'Alnico' it was only 0·02 per cent. Furthermore, the damping coefficient for 'Alnico' rods in mechanical vibration were noted to be very small (of the order, logarithmic decrement equal to $2{\cdot}5 \times 10^{-4}$). The proposal was made that these alloys might have uses as magnetostrictive elements in filter circuits. Finally, mention was made of remarkable time-lag effects in the measured hysteresis loop for 'Alnico' (in the vicinity of H_c). He pointed out that time-lag phenomena might play an important part in the heating and cooling effects observed[12] when a ferromagnetic metal is magnetized step-by-step. Dr. M. McCaig (Permanent Magnet Association) referred to some experiments on the magnetostriction of anisotropic permanent magnet alloys. He concluded that in such alloys domain magnetostriction is normally along the nearest crystallographic 'easy' direction to the preferred direction. Prof. W. G. Burgers referred to Fig. 2 taken from Bradley's recent researches and pointed out that Dr. J. L. Snoek[13] in 1939 observed the two-phase character of single crystals of Fe_2NiAl, by a doubling of certain spots in the X-ray photographs. He considered the recent work greatly extended the earlier findings.

Dr. Shoenberg (Royal Society Mond Laboratory, Cambridge) pointed out that superconductors behave magnetically in exactly the opposite way to ferromagnetic materials in so far that they tend to exclude from themselves all lines of magnetic force. The phenomenon[14] is only observed within a few degrees Kelvin of the absolute zero (less than 10° K.), and so far has remained an obdurate problem in metal physics, defying theoretical solution. Kamerlingh Onnes first discovered the effect about 1911; but most of the work on magnetic properties has been carried out since 1933. It was certainly a matter for surprise to observe that the resistance of some metals such as mercury and lead disappeared completely when a certain temperature, called the 'critical temperature', was reached. Below this temperature the resistance is certainly less than 10^{-13} of its value at room temperature. When a magnetic field is applied, screening currents are induced on the surface of the superconductor which are just strong enough to exclude lines of force from the metal; owing to the zero resistance these currents cannot die away, and the metal behaves as if it had zero permeability or diamagnetic susceptibility $-1/4\pi$. Even more remarkable, however, is the fact that if the metal is cooled in a magnetic field, the lines of force are suddenly excluded when it becomes superconducting. This cannot be a consequence of zero resistance, so that the effectively zero permeability must be regarded as a fundamental property. An interesting experiment due to Arkadiew was described. If a powerful short permanent magnet is released over a large superconducting metal surface curved in the form of a shallow trough, the magnet floats in stable equilibrium above the surface of the metal (curved sides to the trough of metal ensure

stability in the finite case). The explanation given was that corresponding magnetic image-poles of like sign are induced in the pool of superconducting metal which therefore repel one another. The surface currents in a superconductor are associated with a penetration (λ) of about 10^{-5} cm. This value of penetration varies with temperature below the critical temperature, and, from the observed variation, information can be inferred about m/n, where m is the effective mass of the electron and n is the electron density. It was hoped that by studying the penetration effect, much further illumination will be thrown on the superconducting state.

In the brief discussion which followed, Prof. Bates elicited the nature of the Russian experiments which showed that the gyromagnetic ratio for a superconductor was unity, and this eliminated the action of electron spins in explaining this phenomenon. In reply to Mr. Oliver, Dr. Shoenberg explained that the superficial superconducting current probably fell off exponentially from the surface through the penetration distance; this had never been verified experimentally to his knowledge. D. A. O.

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RELATION OF BIOLOGY TO PROBLEMS OF CIVIL ENGINEERING

IN an age when the boundaries of science continue to expand rapidly, and even the general practitioner of a subject tends to 'know more and more about less and less', such a conference as that on "Biology and Civil Engineering", held at the Institution of Civil Engineering during September 21–23, has everything to commend it. The engineer preoccupied with inanimate matter is reminded, or made aware of, the influence of plant and animal life on his structures, in both harmful and helpful contexts. The biologist, for his part, is shown the creatures of his study in a severely practical and workaday setting.

Of the thirteen papers presented during the three days of the Conference, four were general papers dealing with various aspects of soil erosion and floods in relation to vegetal cover and to man's use (or abuse) of such cover. In the two contributions from New Zealand[1,2] there is presented, with many fresh facts from recent survey work of the Soil Bureau (Department of Scientific and Industrial Research), a telling and circumstantial picture of land degradation under faulty practices and of current plans for rehabilitation. The point is made—and needs pressing elsewhere—that a country like New Zealand, possessing a 'youthful' topography, an erodible rock and soil mantle, and an erosive climate (intense downpours, strong winds and prolonged severe frost) could ill withstand any interference with its protective cover, much less the assault of too intensive sheep farming, combined with burning, over the past century; the less so since the natural vegetation had evolved in the absence of fire, grazing mammals and burrowing rodents, all of which were introduced by the European settler. Cleared and burnt forest, whether lowland conifer-broadleaf or highland beech (*Nothofagus* sp.), could not be held to sown pasture after the initial potash fertility had been dissipated, but reverted to shrub (typically *Leptospermum scoparium*) and bracken fern (*Pteridum esculentum*), which further firing and over-grazing would sometimes reduce to low-production swards of native oat grass (*Danthonia* sp.). The interrupted biological chain: imported rabbit – imported stoat and weasel – native bird depletion – reduced forest fruit dispersal: which has prevented tree species from re-occupying shrub land, is of special interest here. The valuable and extensive tussock grasslands suffered similar depletion and regression, including invasion by introduced species like gorse, sweet briar and broom, and such worthless native perennials as cotton plant (*Celmisia spectabilis*) at higher levels and *Nassella trichotoma* at lower. Reclamation work initiated under the Soil Conservation and Rivers Control Act of 1941 emphasizes the special value of willow and poplar in stabilizing slopes and in the structural plugging of gullies; and is making trial of seeding and fertilizing pastures from the air.

The other two papers discussed in some detail the more fundamental aspects of erosion, that is, of 'accelerated', which is essentially man-made, erosion. Long-term run-off experiments at the Agricultural Research Institute of the University of Pretoria are cited[3] to confirm the unique soil-holding value of *close-growing* vegetation—but not of clean-cultivated row-crops like maize—even at a high rate of run-off; also recent work by Ellison and others on the specific effect of falling rain-drops, which demonstrates their disintegrating action on soil aggregates (independently of any subsequent loss from run-off) and confirms the finding of earlier workers, like Lowdermilk, on their damaging potency for sealing over, in the space of two–three minutes, the soil surface pores. The point is made that whereas "erosional damage cannot be completely prevented by any other means than by the efficient use of vegetation", man's food and cash crops may necessarily fall far short of Nature's ideal covering, and consequently "the engineer must step in and help out the agriculturist with engineering methods of control, even if these . . . are only temporary and relatively ineffective".

Unfortunately, many of the necessary data for applying such methods are lacking or defective; for example, a reliable index of the erodibility of soils, safe velocities of flow over different types of vegetation and, especially, a dependable formula for expected water releases from small watersheds. Here it is remarked that the current trend is to apply probability analyses directly to actual measurements of rates of run-off, rather than use the rational formula $Q = CIA$, which seasonal variations in, for example, vegetal cover are apt to confound. These and other difficulties in applying the formula are discussed.

In the complementary paper[4], the protective action of vegetation, and especially of forest, against wind and weather is analysed in terms of the rough hydrological equation :

$$\Sigma = P - [I + E + T],$$

or discharge (streamflow) equals precipitation minus vegetal offset. Salient findings are that "vegetal cover removes more precipitation, physically and organically, than does evaporation from bare soil, that it both creates and maintains storage opportunity in the ground below it, and that it ensures conditions under which clean surface water can be absorbed at especially high rates". The modern forester and hydrologist, nevertheless, make no extravagant claims, for it is concluded that "vegetation should be looked upon as a *moderator* rather than a preventer of floods, as exercising a more important role as a filter and retardant, ensuring the minimum of soil loss and releasing flood water that is comparatively free from detritus, and hence of minimum destructiveness to human welfare".

The first of these findings is interestingly traversed, so far as transpiration is concerned, in a specialist paper[5] from Rothamsted, which quotes the results of recent experiments there on evaporation from grass, bare soil and open water surfaces. It is contended that the evaporation from vegetation is likely to depend more on the acreage than upon the integrated leaf area, since the large amount of latent heat necessary to cause it must come almost entirely from solar radiation. Measurements over a number of years show that evaporation from plentifully watered grass fluctuates with the weather in the same way as evaporation from an open water surface, but averages 20 per cent less in summer, 40 per cent less in winter and 30 per cent less in equinoctial months, most of this reduction being ascribable to the closing of stomata at night and their intrinsic resistance to vapour diffusion. These factors, it is suggested, may be applicable to any continuous leafy cover, for example, forest. Calculated values of evaporation from grassland, assessing soil moisture deficits on a basis of about 3 in. of available water, are shown to accord closely both with direct soil moisture readings and with recorded dates on which field drains started to run.

The remaining papers were concerned with the role of vegetation in certain special branches of civil engineering. To the railroad engineer[6,7] it is an invaluable, if somewhat tricky, ally in stabilizing his cuttings and embankments. Interesting points brought out include : (1) the increasing use of sewage sludge as a top dressing in place of soil, and as a quick stabilizer of slipping slopes ; (2) the recent recourse to carefully and widely blended seed mixtures for grassing ; (3) the marked promise of bituminous surface treatments—adapted from wartime aerodrome experience—for grassing slopes. The cold bitumen emulsion is sprayed in a thin skin over the soiled and seeded surface, preferably with a dressing of sand before and after, and results in a quicker and more deeply rooted flush of grass remarkably free of competing weeds. As regards other forms of vegetation, stabilizers now largely favoured include the common ivy and traveller's joy (*Clematis vitalba*) on steep chalk, the hardy and adaptable *Cotoneaster henryana*, an evergreen shrub brought from Central China, and locust (*Robinia pseudoacacia*), rowan, birch and oak among the trees, the locust proving particularly useful on clays.

In quite another context, vegetation still plays an indispensable part in the stabilizing of sand dunes[8,9]. Among interesting features of present-day practice are the use of tree lupins and, in America, of sea-oat (*Uniola paniculata*) in place of marram grass as initial binders ; the sowing of annual lupins both to nurse other vegetation and to add stabilizing humus ; and the trials recently begun of seeding lupins and grass from the air. The management of stable dunes as forest rather than pasture finds general favour with the experts, who also stress the need for perpetual vigilance in maintaining an unbroken seaward front.

Vegetation is seen in quite a different light by the roads and buildings engineers[10,11] wherever clay below foundations gets invaded by roots. These, by their varied seasonal demands for moisture, cause large volume-changes in clayey soils and so endanger overlying structures. The problem is world-wide, but modern shallow foundations and the exceptional drought of 1947 have brought it into prominence in England, particularly on the heavy clays of the south-eastern half, which possess a liquid limit of some 70–80 per cent of dry weight. A series of levelling points established in June 1947 at Garston at various depths in grass-covered heavy boulder clay revealed a maximum vertical settlement of about $2\frac{1}{2}$ in. On bare ground it will not exceed $\frac{1}{2}$ in. ; near fast-growing trees it may exceed 4 in. For buildings on such clays, a minimum foundation depth of 3 ft. and no trees within root radius are considered prudent rules ; but with stability and amenity so much in conflict, an alternative under active investigation is the use of short-bored pile foundations spanned by beams carrying the external walls. In the case of roads, recent surveys by the Road Research Board show that damage is not likely to be serious except with trees, and then only in urban areas where they are set in paved footways or where the rainfall distribution is affected by concentrated building. Tentative recommendations include the avoidance of fast-growing species, like poplars, within 50 ft. of the carriageway on heavy clays ; the need for co-operation of biologists at the soil survey stage of all road planning is also stressed. Much more research is needed, discussion showed, on the precise water changes caused by root spread. A cheap, root-impenetrable membrane, to be introduced near foundations, should not, it is considered, be beyond modern scientific resource.

In the concluding papers[12,13], vegetation of a special sort—planktonic algæ—is viewed as a chronic and complex polluter of stored water and of the filters purifying it for human use. In open reservoirs, the abstracting of nutrients or of 'limiting' substances, like phosphates, from the replenishing source does not, in the opinion of the authors of the first paper, offer a full solution, nor does algicide treatment (which is liable to recoil biologically). For lowland Britain in particular, they stress the paramount need for minimizing thermal stratification, with its inevitable de-oxygenating of the deeper water and the contaminating reactions that follow its seasonal disruption and overturn ; even in its absence, chemical stratification of biological importance may exist. To this end, the following suggestions for optimum reservoir design are, *inter alia*, offered : (1) intake filters of 40–50 micron fineness to reduce accession of organic matter (the plankton pabulum) ; (2) orientation to maximum wind force ; (3) introduction of booms and baffles ; (4) multiple levels of

draft; and (5) suitably located scum spillways. That the key to the pollution problem is better circulation of the water-mass finds support in the interesting case of the 60-ft. deep Hollis Reservoir in Trinidad[12]. Here there are marked wet and dry seasons, intense rainfall, small variation in temperature, whether diurnal or annual, and, owing to its sheltered position, very little wind. As a result, vertical water circulation is restricted to the upper 10–14 ft., with no seasonal overturn, and the consequent heavy bottom build-up of plankton may extend to within 5 ft. of the surface during the dry season. Further, the sub-aerobic layer at the 20–35 ft.-level, which includes *Anabæna*, *Merismopedia*, and *Oscillatoria* blue-green algæ, suffers an extensive upheaval whenever an influx of cold water from heavy rains under-penetrates it; this is followed by the death *en masse* of its plankton content, with dire results—particularly from *Oscillatoria*—for water purity and filterage. F. R.

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THE SIGNALS RESEARCH AND DEVELOPMENT ESTABLISHMENT, CHRISTCHURCH

THE Signals Research and Development Establishment of the Ministry of Supply held three 'open days' during September 22–24. This was the first time that S.R.D.E., as it is known, has opened its doors to the public to exhibit the work carried out there. It was fortunately possible for Mr. J. Freeman, Joint Parliamentary Secretary to the Minister of Supply, to attend and address the visitors on September 23.

S.R.D.E. has its origin in the Wireless Telegraphy Experimental Establishment which was formed at Aldershot in 1904. It was transferred to Woolwich in 1916 and became the Signals Experimental Establishment. Early in the Second World War, it was renamed the Signals Research and Development Establishment, and was moved to its present location in Christchurch in 1943.

The No. 10 Set is probably the best known of its war-time achievements. This is a multi-channel radio set, the first communication set of its kind to use centimetre waves. The set played an important part during the advance across the Netherlands and Germany. Field Marshal Montgomery paid a special tribute to it in a message he sent to the Radio Convention arranged by the Institution of Electrical Engineers in March 1947. S.R.D.E. also carried out pioneer work on what is now known as 'miniaturization'. During the War, radio sets became more and more complicated. At the same time, the Army was demanding smaller and lighter equipment. This problem could only be solved by giving detailed consideration to each of the very numerous components in turn, searching for new materials of superior properties, and ensuring that every part of a component was essential and was bearing its maximum safe load. The result was that some equipments were reduced in size to as little as a quarter or even a fifth of their previous bulk.

Another problem arose when the British armies commenced to fight in tropical jungles. Equipment which had given satisfactory service in Europe and North Africa rapidly succumbed to attack from moisture and fungus. Moisture barriers had therefore to be devised in all packaging for transport, and either round the complete items of equipment when in use, or else round the individual components in the equipment (thus providing either sealed sets or sealed components in unsealed sets). Time did not allow tests on these developments to be carried out in the jungle, so the jungle had to be brought to the Establishment, in the form of tropical chambers and similar testing facilities.

Pulse Code Modulation and Digital Computation

In the earliest forms of telegraphy, communication was made by on-off keying. This simple system is the basis of the very topical pulse code type of modulation which has created so much interest recently both in Great Britain and in the United States. An experimental equipment was shown demonstrating the transmission of speech using this method of modulation. In this system the instantaneous amplitude of the speech wave-form is sampled at discrete time-intervals (6,600 times per second in the equipment shown) and the amplitude of each sample is transmitted as a coded series of on-off pulses. At the receiver the incoming pulses enable the successive samples of speech to be built up to the level originally measured at the transmitter. With a five-unit code the amplitude of each sample can be indicated to the nearest of 2^5 or thirty-two levels.

Since the transmitted signals are merely on-off pulses, minimum demands are made on the linearity in the transmission equipment, whether radio or cable. Until the condition is reached where noise or interference obliterates a number of the received pulses, the latter can be reconstituted at the receiver to correspond exactly with those originally transmitted. For the same reason, in long links, unmutilated pulses can be regenerated at repeaters so that any cumulative effect of noise or interference can be eliminated. The speech quality obtained with various numbers of amplitude-levels was demonstrated. With only four levels the received speech was intelligible though of poor quality. When the full thirty-two levels were employed, good telephone quality was obtained.

Electronic counting techniques are becoming popular in many applications to electronic control systems. An example of a counting circuit developed at S.R.D.E. was shown in the form of a frequency-dividing circuit operating on the stepping counter principle. Designed to replace the multi-vibrator in such applications as frequency-standardizing equip-

ment and quartz crystal clocks, it is capable of stable division ratios as high as 30 in a single stage incorporating a pentode and double-diode. When used with a suitable input amplitude limiter, it is insensitive to wide variations of input frequency and amplitude, and will tolerate changes in high-tension supply voltages of ± 15 per cent when dividing by 30 and proportionally greater changes at lower ratios, thus dispensing with the need for stabilized power supply.

Research on Radio Materials

Researches in the physics of materials were demonstrated by two exhibits, one dealing with nuclear magnetic resonance and the other with an investigation on the properties of thin films deposited on metals. The phenomenon of nuclear magnetic resonance arises from transitions between the quantum states of nuclear spin orientation relative to an applied magnetic field. The energy-level differences are such as to bring the radiation concerned into the low radio-frequency band. The method first described by Bloch[1] was used to show the hydrogen (proton) resonance in water at a frequency of 6 Mc./s. The sharpness of resonance is limited by magnetic reactions within the substance and, as the resonant frequency is directly proportional to the applied magnetic field, to non-uniformity of this field. However, values of Q as high as 50,000 for proton resonance in water have been obtained.

Nuclear magnetic resonance will undoubtedly be of value in the calibration and control of magnetic fields—by reference to frequency standards. The converse possibility also exists of using the effect to provide continuously variable oscillations and filters of relatively high stability in which the magnetic field is controlled by indirect means. It is the last aspect which is of particular interest to S.R.D.E.

Telemetry

The successful prosecution of research into the characteristics of high-speed projectiles can only be achieved by staging a large number of test flights, during which an accurate and detailed knowledge of the behaviour of a projectile and its mechanism is obtained. Equipment was shown which was developed specially for transmitting this essential data to the ground by radio link and recording it at the receiver in a form convenient for subsequent analysis. Typical of the quantities telemetered are accelerations, pressures, temperatures, electrical currents and voltages, positions of moving parts and the timing of events. In the S.R.D.E. telemetry equipment, the various parameters to be measured are dealt with in sequence at the transmitter in the projectile. The signal is received on the ground, where electronic switching circuits are provided so that the different data may be recorded on separate tracks by cathode ray tube photography. The equipment has been designed to be as versatile as possible; for example, in the receiver, which incorporates cathode ray tubes, facilities are provided for recording the same measurement simultaneously on the traces of separate tubes. In addition to increasing the reliability of the equipment, this procedure allows related parameters to be recorded in close proximity, so making interpretation of the results as simple as possible.

Quartz Crystals

Examples were shown of the different types of quartz crystal units used for frequency-control in Army signals equipment from 1928 to the present day. The results of research into the effects of X-ray irradiation of different cuts of quartz crystals were also shown.

The 'S' Spring

A new mechanical principle, as yet but partially explored, was illustrated by the 'S' spring. A strip of thin spring-steel is clamped at each end and the clamps are twisted in opposite directions, thus forcing the strip into an S-like form. By altering the angles of twist of the clamps the stiffness of the centre of the spring can be varied continuously from a positive, through zero, to a negative range of values. Moreover, the movement of the centre point is almost linear. A vibration table, capable of carrying loads of 100 lb., and supported on four 'S' springs, was shown in action in the Durability Testing Section.

Radio Sets

(*a*) *Field Pack Sets.* A number of different types of portable transmitter/receiver sets, including those used during the War, were shown. The most recent set is the Wireless Set No. 88, a compact equipment weighing only 11 lb. with its batteries, designed for use by infantry. It operates in the very high frequency band, is frequency-modulated, provides four crystal-controlled channels and gives a range of 1½ miles over average country.

(*b*) *H.F. Radio Equipment.* A number of high-frequency receivers were exhibited. One of these, the *R*209, is a small communication receiver using 'miniature technique', and contained in a completely sealed case. The receiver was shown working submerged in a water-tank. The receiver station of a radio teleprinter station using carrier-frequency shift was demonstrated taking long-distance traffic.

(*c*) *Stabilized Oscillators.* For some years S.R.D.E. has worked on the problem of stabilizing oscillators without using quartz crystal control. A stabilized oscillator having a constancy approaching that of a crystal-controlled circuit was demonstrated. Novel vapour-pressure thermostats which have been found necessary for maintaining constant the temperature of the master oscillator were also shown.

Line Equipment

In the Line Laboratories a comprehensive array was shown of Army teleprinters, switchboards, carrier telephone sets and testing instruments. A particularly interesting instrument is the pulse fault locator. This sends a radio pulse along a line in which a fault, either a disconnexion or a short circuit, is suspected. The pulse is reflected at the fault, because this causes a discontinuity on the transmission characteristics of the line, and returns to the set. The time taken by the pulse to do the journey is measured and the distance to the fault determined.

Electro-Acoustics

Demonstrations were given illustrating the adaptability of the ear. Recordings showed that speech which had been seriously distorted in a number of ways can still be intelligible. This was followed by recordings taken over some transmission systems which apply various forms of controlled distortion in order to improve intelligibility under adverse conditions or to achieve economies in the transmission path.

An exhibition of Army telephone instruments showed the evolution from the early sets to the latest efficient light-weight telephone set which is carried in a small webbing-pouch by the lineman.

Equipment and Component Testing

S.R.D.E. has a very well-equipped laboratory for testing component parts and complete sets. Every imaginable climatic test can be applied—heavy and tropical rain, sand-storms, low temperatures and pressures, even tropical storage, which includes typical fungi and mould growths. The rigours which Army sets must withstand were also demonstrated by vibration, bumping and dropping tests. Microscopy and X-ray examinations are used to assist in locating faults.

The G.O.C. Southern Command provided a display of R.E.M.E. mobile workshops. These are lorry vehicles provided with work-benches, test equipment and repair facilities ingeniously arranged to make the most of the limited space. By means of these workshops, Army signals equipment is maintained and kept in good repair in the field. R.E.M.E. personnel were shown at work repairing radio and line sets.

[1] Bloch, F., *Phys. Rev.*, **70**, 460 (1946).

OBITUARIES

Prof. F. Weidenreich

THE distinguished anatomist Dr. Frank Weidenreich died after a short illness in New York on July 11, 1948, at the age of seventy-five. Although he was known to the present generation primarily for his work in the field of human palæontology, he had in the early part of his career gained a considerable reputation as a histologist. After taking his doctorate of medicine in the University of Strassburg in 1899, he joined the staff of the department of anatomy and studied under Prof. Schwalbe, and in 1904 he was appointed professor of anatomy. His interests at that time were concentrated on the blood-forming tissues of the body and he contributed a series of papers on the histology of the spleen and the blood-lymph system. Some of these papers, it is interesting to note, are still quoted as standard references.

At the end of the First World War, Weidenreich was compelled to vacate his position at Strassburg, and in 1921 he was appointed to the chair of anatomy at the University of Heidelberg. From that date he seems to have transferred his attention to problems of physical anthropology, mainly, it would appear, as the result of studies which he made on the structure of bone in relation to function. In 1921, he published an extensive monograph on the comparative anatomy and evolution of the human foot, and in 1926 he entered the field of human palæontology by a comprehensive study of the famous Ehringsdorf skull.

In 1928, Weidenreich was elected to the chair of anthropology at Frankfurt. This he held until 1935, when the difficulties of the political situation in Germany became too great. It was then that Weidenreich was invited to take the chair of anatomy at Peking Union Medical College, recently vacant by the death of Dr. Davidson Black. This appointment was combined with the directorship of the Cænozoic Research Laboratory of the Geological Survey of China. Dr. Weidenreich's energetic studies of the skeletal remains of the early type of fossil man, *Sinanthropus*, excavated at Choukoutien, are too well known to need recapitulation here. He produced a series of magnificent monographs, richly and profusely illustrated, which proved of the greatest value to anthropologists everywhere. Their value has now been even more enhanced by the fact that almost all the original material on which these monographs were based—material of supreme importance to the student of human evolution—was lost during the Japanese invasion of China.

Dr. Weidenreich himself was forced to leave China in 1941 in order to escape the invasion. He made his way to the United States, and was there offered hospitality in the American Museum of Natural History. Here he continued his researches, and published a number of articles in which he strove to integrate the results of his earlier studies in a constructive account of what to him appeared to be the probable sequence of human evolution. Shortly before his last illness, Dr. Weidenreich was engaged on an intensive study of the Solo skulls discovered in Java a few years before the War, and brought to America after the cessation of hostilities by Dr. von Koenigswald. This study was still unfinished, but it was rapidly approaching completion—sufficiently so, it is to be hoped, to make possible its publication in some form.

Weidenreich's life was one of intense and continuous intellectual activity, the more remarkable since his work was so often interrupted by the disruptive effects of wars and political dislocations. But he had an indomitable spirit, and his long series of scientific publications bears witness to the energy with which he pursued his intellectual inquiries, regardless of obstacles which would certainly have frustrated a lesser man. W. E. LE GROS CLARK

Dr. J. W. S. Macfie

BY the death of Dr. J. W. S. Macfie at the age of sixty-nine, tropical medical research has lost a worker of outstanding ability and high character. He was educated at Oundle School and at the Universities of Cambridge and Edinburgh, taking the degrees of B.Sc. and M.B., Ch.B. (1906), and later the D.Sc. After residence at the Radcliffe Infirmary, Oxford, and work in physiology under Sir Charles Sherrington, he took the diploma of the Liverpool School of Tropical Medicine in 1910 and joined the West African Medical Staff. He investigated sleeping sickness in Nigeria and took charge of the Medical Research Institute there. In 1914 he became successively pathologist in charge and director of the medical laboratory at Accra, Gold Coast, and held this post until his retirement in 1923, with an interval from 1917 to 1919, when he worked in Liverpool with Prof. Warrington Yorke and others on malaria. Shortly before his retirement he designed the plan of the present Medical Research Institute at Accra. He afterwards studied in Liverpool and London, accompanied Dr. Melly with the British Red Cross to Abyssinia in 1935, and during the Second World War had war duties in London and went to Egypt, Palestine and Syria as malariologist in the R.A.M.C. He was awarded the Mary Kingsley Medal by the Liverpool School of Tropical Medicine.

Macfie was a keen investigator with original ideas and a critical mind; his laboratory technique was of a high standard, and his experiments seldom needed repeating. His researches in tropical medicine

included protozoology (trypanosomes, malaria parasites, amœbæ), helminthology (schistosomes, filariæ, hookworms, guineaworm), entomology (mosquitoes, Ceratopogonine midges and other arthropods), and fungi (*'Nocardia'* or *Discomyces*). His articles and annual reports were written in a clear and attractive style, at times with a whimsical touch, and illustrated with excellent photographs taken by himself; an examination of paper money in Accra, for example, was recorded under "Filthy Lucre". He was much in favour of closer association between research workers in the Colonies and those in Britain, and even thought that a tour of duty might well be shortened by a month to be spent in one of the home laboratories.

It was my privilege to work with Macfie and his friend and colleague, the late Dr. Alexander Ingram, at the Accra laboratory nearly thirty years ago, and I then formed a very high opinion of his personal qualities. He was devoted to research, while not neglecting routine, and his outlook was quite uncommercial and free from self-interest. Though rather shy and reserved, he would firmly resist any moves which he thought would impair the efficiency of his department. The Gold Coast Government once offered him £500 in recognition of his work; but he declined it, saying that the laboratory work was done by the whole staff, and suggested that the money be given to assist further research. His health was never good and he could not stand a long tour of residence; but every day was filled with work and he grudged the loss of time when, as sometimes happened, interruptions were too frequent. He entered little into the general social life at Accra, but liked to entertain a few friends; as he was an excellent host and good companion, such occasions were very enjoyable. He took a great interest in original work by junior men, and would write helpful and encouraging letters to those working alone in out-stations. He was kind and sympathetic to his servants and staff and was liked and respected by them as, indeed, he was by all who knew him. His "Ethiopian Diary" is characteristic of the man. J. F. CORSON

Mr. G. H. Gabb

GEORGE HUGH GABB, who loved to style himself the 'Father of the Scientific Antiquaries', died on August 11, aged eighty years. He was educated at Bishops Hatfield School and later studied chemistry at the Polytechnic. He was for some time analyst to Welford and Son, and in 1892, in conjunction with Dr. Faber, he invented and put on the market the first type of humanized milk. Later he set up as a consultant on his own account. He retained an interest in public health, and, during a part of the period when he was a councillor of St. Pancras, was chairman of the Public Health Committee.

In 1885, Gabb became interested in the history of science and began to acquire his remarkable collection of scientific antiquities. He was at once a fine craftsman and a connoisseur. He had great understanding and sympathy with the instrument-makers and studied their crafts, thus becoming a master-hand at the treatment and conservative restoration of masterpieces. His understanding of the quality of early work enabled him unhesitatingly to detect forgeries and 'reconstructions'. As one of the first of collectors at a period when there was little interest in old scientific instruments, he was able to make a collection which consisted of really first-class specimens in perfect condition. Among his discoveries were the astrological astrolabe of Queen Elizabeth (*c.* 1570), the earliest dated English theodolite (1574) and the earliest known dated telescope (1646). His collection was acquired in 1937 by Sir James Caird, who presented it to the National Maritime Museum. Gabb was also an expert in the field of scientific iconography, and discovered many unknown or lost portraits of men of science, ranging from Galileo to Dalton. He was a severe critic in such matters and discredited many portraits accepted as genuine. His interests covered a wide field. He was an enthusiastic photographer, and the last survivor of a small group of X-ray workers who were experimenting in the years 1896–97; among his long succession of exhibits at the Royal Society's conversaziones was an X-ray photograph of his hand, made in February 1896.

Gabb was a remarkable character—a very typical collector, who would stick at nothing to acquire the instruments he coveted. He was by no means blind to his own qualities in this field, and his amusing conversation was not a little marred by its egocentric character. None the less, he was a mine of information and gave to his 'antiquarian sons' treasures of technique which could have been learnt nowhere else. To the Royal Society he left £1,000 to provide for a Leeuwenhoek Lecture on some subject in the field of microbiology; to the Science Museum a number of instruments of historical interest; to the University of Oxford, for the Museum of the History of Science, a collection of drug-jars and some sixty engravings and portraits; and to the Royal Institution a number of letters and relics of Michael Faraday.

We owe a great debt to George Hugh Gabb for his preservation for posterity of so many of the fast-disappearing relics of the great men of science on whose shoulders we stand. F. SHERWOOD TAYLOR

Dr. J. H. Shaxby

DR. J. H. SHAXBY, who died at Cardiff on September 29, was born at Ashford, in Kent, on May 23, 1879. After his schooldays at Canterbury, he studied at Aberystwyth and then at the Royal College of Science, London, where he became a demonstrator in physics and where he lost an eye in a laboratory accident. In 1904 he joined the staff of the Physics Department at Cardiff and eventually became director of the Viriamu Jones Physical Research Laboratory. In 1924 he relinquished that post when he was appointed lecturer in special sense physiology in the Physiology Department of the School of Medicine at Cardiff, a position which he held until he retired in 1946, but without severing his connexion with the Department. Among many other activities, he was a member of the Physiology of Hearing Committee of the Medical Research Council and was chairman of a committee of the Physical Society on Defective Colour Vision.

Shaxby's scientific interests covered a wide field. An early book of "Elementary Electrical Engineering" (1907) was followed by studies in Brownian movement. Then his service as an X-rays officer in the First World War led to papers on methods for localizing foreign bodies by X-rays. After the War he returned to more purely physical problems with work on vapour pressures and the isothermals of vapours, on the properties of powders, on the diffusion of suspended particles, and on the relation between

density and temperature in fluids. An earlier interest in colour vision became dominant after about 1930 and culminated in two ingenious theoretical papers (*Phil. Mag.*, 1943 and 1946); but during the same period Shaxby was also much occupied with the physiology of hearing, and in particular with phenomena at the threshold of audition, and with the binaural localization of sounds. During 1932–35 he undertook long-range reception of gun-fire noises for the Air Ministry, and in 1937 he became interested in geomagnetic surveying, for which he invented a device for varying the sensitivity of the magnetometer.

This sketch by no means exhausts Shaxby's many interests even in the field of science. As a man, he was a most lovable and loyal colleague with whom it was a pleasure and a privilege to work.

T. GRAHAM BROWN

WE regret to announce the following deaths:

Dr. S. C. Bradford, until 1938 chief librarian of the Science Library, South Kensington, and founder, with the late Prof. A. F. C. Pollard, of the British Society for International Bibliography, on November 13, aged seventy.

Mr. R. Elmhirst, director of the Scottish Marine Biological Laboratory at Millport, whose forthcoming retirement was announced in *Nature* of October 30, p. 688, on November 13, aged sixty-four.

Prof. Karel Kavina, director of the Botanical Institute of the Prague Technical University for many years and known for his "Atlas of Fungi" (1927), a second enlarged edition of which appeared this year, aged fifty-eight.

Mr. E. Platt, geologist and leader of the Falkland Islands Dependencies Survey at Admiralty Bay, King George Island, South Shetlands, on November 9.

NEWS and VIEWS

Royal Society: Medal Awards

H.M. THE KING has been graciously pleased to approve the following recommendations made by the Council of the Royal Society for the award of the two Royal Medals for 1948:

Prof. Harold Jeffreys, for his distinguished work in geophysics and his important contributions to the astronomy of the solar system;

Prof. James Gray, for his distinguished researches in cytology, ciliary movement and particularly his anatomical and experimental studies of animal posture and locomotion.

The following awards of medals have been made by the president and council of the Royal Society:

Copley Medal to Prof. A. V. Hill, for his distinguished researches on myothermal problems and on biophysical phenomena in nerve and other tissues.

Rumford Medal to Prof. F. E. Simon, for his outstanding contributions to the attainment of low temperatures and to the study of the properties of substances at temperatures near the absolute zero.

Davy Medal to Prof. E. L. Hirst, for his outstanding work in the determination of the structure of sugars, starches, plant gums and especially of vitamin C.

Darwin Medal to Prof. R. A. Fisher, for his distinguished contributions to the theory of natural selection, the concept of the gene complex and the evolution of dominance.

Hughes Medal to Sir Robert Watson-Watt, for his distinguished work in atmospheric physics and in the development of radar.

British Astronomical Association: Dr. J. G. Porter

MR. F. M. HOLBORN retired from the presidency of the British Astronomical Association on October 27 and was succeeded by Dr. J. G. Porter. Dr. Porter is well known in astronomical circles, not only in connexion with his broadcast talks, but also for his work for the Computing Section of the Association, of which he has been director for many years. He has also carried out investigations on the speeds of meteors and has shown that these bodies are members of the solar system, none of the cases that he has dealt with showing hyperbolic velocities; this would seem to dispose of the results of the Harvard College Observatory Expedition to Arizona some sixteen years ago.

Los Angeles State and County Arboretum: Dr. Frans Verdoorn

DR. FRANS VERDOORN, managing editor of *Chronica Botanica*, has been appointed director of the Los Angeles State and County Arboretum at Arcadia, California. He will assume the directorship of this new arboretum in the immediate future. It is planned to develop a modern arboretum and botanical garden at Arcadia with various educational and research departments. Dr. Verdoorn will continue to edit *Chronica Botanica* and other journals. Some of these will be published in the future by the Los Angeles State and County Arboretum, while others will be transferred to a commercial publisher.

Dr. Verdoorn, a native of the Netherlands, went to the United States in 1940. Formerly known for his work in cryptogamic botany, he has lately been occupied chiefly with historical studies and international relations work. He was an assistant at the Buitenzorg Botanic Gardens, Java, in the 1930's and has been a research fellow at Harvard University since 1940. During the war years he did much work on Latin America and South East Asia for various government agencies. He received the first Mary Soper Pope Medal in 1946, and has just been appointed chairman of the International Phytohistorical Committee.

Control of Nationalized Industries

IN an address on "The Consumer in Relation to Non-Competitive Industry", delivered at the fifty-second Oxford Management Conference of the British Institute of Management held at Scarborough on October 16, Mr. Herbert Morrison said that increasing use of economists is being made in the work of government; but his address was chiefly concerned with the administrative policy pursued to protect the consumer in industries where full competition does not operate—a field which is not coterminous with that of public ownership. While under the competitive system the threat of withdrawal of custom could be a spur to efficiency, the corresponding safeguard with socialized industries should be their sensitiveness to

public complaint. The consumer, he said, is entitled to demand that such industries avoid extravagant administration, attain a high degree of efficiency, pass to the consumer a substantial share of the results of higher productivity and have sufficient regard to the legitimate wishes of the consumer in matters of quality and variety.

Most of Mr. Morrison's address was devoted to an outline of the general organisation of the various public boards controlling certain industries in Britain, in which he stressed particularly the safeguards provided for the interest of the consumer. We have to rely on the various boards, Mr. Morrison said, to hold the balance fairly between consumer and worker, and he concluded that the consumer would be primarily dependent for a fair and reasonable level of price on the efficiency of the boards and their ability to keep both management and workers 'on their toes'. Such public boards should provide a reasonable safeguard against gross discrimination between consumers, but the address contained little evidence that the conditions Mr. Morrison specified are, in fact, being observed. It cannot now be seriously contended that even the Post Office passes on to the public the advantages in speed and efficiency which technical improvements have made possible, and the difficulties experienced in raising questions in the House of Commons regarding the public boards suggests that new means must be sought of making them sensitive to public opinion.

Australian Council for Scientific and Industrial Research

DESPITE grave misrepresentation of its motives, the Executive Committee of the Australian Council for Scientific and Industrial Research appears to have convinced the Commonwealth Government that scientific work for war purposes should be conducted under the Ministry of Supply or the Ministry of Defence rather than under the Council. The contention is that the conditions of secrecy and military security essential nowadays for war-work will require an atmosphere in which the normal activities of the Council on behalf of primary and secondary industry simply cannot flourish. The Council has for twenty-two years operated under an Act, originated by Viscount Bruce, giving it a high degree of freedom and independence; for many reasons it is believed that, in existing conditions, the two contrasting lines of work cannot be effectively controlled by the one body.

In providing for the transfer to another Commonwealth agency, under public service board control, of the small amount of work bearing on defence at present conducted in the laboratories of the Council for Scientific and Industrial Research, a Bill now before Parliament unfortunately goes further and opens the way for subjecting any or all of the Council's activities to public service board procedure and regulations. Strong exception is being taken by scientific men and societies in Australia to this action, which is regarded as a serious threat to the spirit and successful working which have characterized the Council for Scientific and Industrial Research in the past.

Australian Journal of Scientific Research

A NEW periodical of high standard, the *Australian Journal of Scientific Research*, has recently been launched by the Australian Council of Scientific and Industrial Research, Melbourne, in collaboration with the Australian National Research Council (see *Nature*, August 7, 1948, p. 210). It is being issued quarterly in two series, Series A (Physical Sciences) and Series B (Biological Sciences), the price of each being 7*s*. 6*d*. The editor and chairman of the editorial board is Dr. N. S. Noble, and the other members of the board are Profs. W. J. Dakin, E. J. Hartung, L. H. Martin and J. G. Wood.

The first number (March 1948) of Series A contains seven papers on physical, chemical, metallurgical and meteorological subjects, indicating the variety of researches undertaken or sponsored by the Australian Council of Scientific and Industrial Research. These include: an analytical treatment, by G. H. Godfrey, of the distribution of light intensity in the Fraunhofer diffraction pattern of continuous light sources, in which attention is directed to certain diffraction effects which have not been previously recorded but which are in agreement with the theory; a study, by V. D. Hopper and A. M. Grant, of the effect of a horizontal wall on the motion of oil drops, of radii 5–15 μ, falling in air, in order that the corrections to be applied in the precise determination of the electronic charge by the oil-drop method may be accurately made; observations on a strong variable source of radio frequency energy in the constellation of Cygnus; a microscopic and X-ray examination of the deformation or recrystallization of a duplex brass; and the testing of molecular layers of the silicones on various metal surfaces for their boundary lubricating properties.

German Scientific and Technical Periodicals

THE Foreign Office of Great Britain has recently compiled a list of more than three hundred German scientific and technical periodicals which have resumed publication. The list is divided into the following sections: agriculture and forestry; mathematics, physics and chemistry; medicine; natural science; and technology and industry. Very short notes, including the price where listed, are given with each periodical. Inquiries regarding the list should be made to the Foreign Office (German Section), Room 211, King Charles Street, London, S.W.1.

Financial Aid for Delegates at Conferences

THE British Council has a small fund for the assistance of overseas delegates wishing to attend national or international conferences held in the United Kingdom on scientific subjects including agriculture, engineering and medicine. Except in special circumstances, fares to and from the United Kingdom will not be paid, and the grants are mainly designed to cover subsistence of the delegate for the duration of the conference up to a period of two weeks. Conveners of conferences to be held during the period April 1, 1949–March 31, 1950, should apply to the Director, Visitors Department, British Council, 3 Hanover Street, London, W.1, giving full details including the number of delegates requiring assistance and their nationalities. Such information should be lodged preferably not later than January 15, and replies will be made by the end of February.

World Federation for Mental Health

THE World Federation for Mental Health, formed at the time of the international congress in London last August, has now been officially recognized for consultative purposes by the two United Nations

bodies—the World Health Organisation and Unesco. The president of the World Federation, Dr. J. R. Rees (Great Britain), has expressed the hope that this consultative arrangement will lead to a further recognition of the importance of mental health in efforts to establish a healthier and happier world society. Dr. Rees also announced that the Federation has accepted the invitation of Unesco to send an observer to its general conference which opened at Beirut on November 17. The Federation is being represented by Dr. M. K. el Kholy, of Egypt, the member for the African Continent on the Executive Board.

The World Federation already comprises twenty-one mental health associations of different nations, and others are expected to be admitted to membership in the near future. Dr. André Repond, of Switzerland, now vice-president, in accordance with the by-laws of the Federation, will succeed Dr. Rees as president next year. Prof. H. C. Rümke, of Holland, is chairman of the Executive Board, which will meet in Amsterdam in January. Arrangements are also now being made for the Assembly of the World Federation to be held in Geneva next August, when delegates from all over the world will be present.

P. F. Frankland Memorial Lecture

THE Birmingham and Midlands Section of the Royal Institute of Chemistry is endeavouring to collect £1,500 to establish a memorial lecture in honour of Percy Faraday Frankland, who occupied the Mason chair of chemistry in the University of Birmingham with great distinction during 1894–1918 and who died two years ago. The lectures will be delivered in Birmingham at intervals of three to four years and will deal mainly with original work; they will be published and may be expected to make a notable contribution to chemical literature. All money subscribed goes to the endowment; cheques drawn in favour of "P. F. Frankland Memorial Lecture", crossed a/c payee, should be sent to Mr. E. M. Joiner (secretary, Birmingham and Midlands Section, Royal Institute of Chemistry), 15 Halton Road, Sutton Coldfield, Warwickshire.

Lantern Slides of Diagrams, Formulæ, etc.

IN *Nature* of June 29, 1946, p. 879, and several earlier issues, correspondents described methods they had used successfully for writing on glass. Mr. E. H. Leach, University Laboratory of Physiology, Oxford, states that any ink to which a drop or two of a solution of a synthetic detergent ('Teepol' type) has been added can be used for writing on any clean glass surface. Indian ink appears to be the most suitable. Some proprietary brands of ink appear to contain synthetic detergent and require no further addition. Glassware and microscope slides can be marked with such inks.

Hawaiian Libraries

MANY people are unaware that excellent libraries exist in Hawaii in conjunction with that country's museums, university, research institutions and archives of the Government. For information on the holdings of these libraries a "Union List of Serials in Hawaii" is being prepared; the Committee on the Union List, Hawaii Library Association, Honolulu, Territory of Hawaii, invites pre-publication orders at 6 dollars a copy.

Conference on Organised Information Services

THE Northern Branch of Aslib has arranged a conference on the general theme of the value of organised information service to industry, commerce and education, to be held at the North of England Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne, on December 7. The chair will be taken by R. Trevor Jenkins, technical manager, Vickers-Armstrongs, Ltd., Elswick and Scotswood Works, Newcastle-upon-Tyne. The conference will be opened at 10 a.m. by the Lord Mayor of Newcastle-upon-Tyne. Dr. V. E. Parke will speak on "Intelligence: Some Fundamental Principles", and will be followed by Mr. E. Austin Hinton on "Industrial, Technical and Commercial Information: The Contribution of the Public Library". In the afternoon session, at 2.30 p.m., Mr. R. O. MacKenna will speak on "Information Service from the point of view of the Universities", and will be followed by Mr. T. S. Nicol, who will deal with the point of view of professional associations. Miss J. Scurfield will speak on "The Regional Library Bureaux"; Miss E. M. R. Ditmas will deal with the work of Aslib, and Mr. R. Brightman with that of the Northern Branch. Conference tickets can be obtained (5*s*. each) from the local organising secretary, Mr. M. G. Cahill-Byrne, Vickers-Armstrongs, Ltd., Elswick Works, Newcastle-upon-Tyne, 4.

Comet 1948 l

DR. R. D'E. ATKINSON, who led the Royal Observatory eclipse expedition, cabled confirmation of a bright comet seen in the southern sky early in November. During the eclipse on November 1 a photograph showed that the comet was 1° 33′ from the centre of the sun, and it was then very bright with a tail. It has been seen in different parts of the southern hemisphere since then. Its brightness has been estimated as mag. 2. Its daily motion is approximately −8·1m. in R.A. and −51′ in declination. It is doubtful whether it will be seen from the British Isles. The latest description from the Cape Observatory states that the object is diffuse with central condensation or nucleus, and that the tail exceeds 1° in length; hence some of the Press reports about the length of the tail were probably exaggerated.

The Royal Observatory, Cape Town, has communicated the following parabolic orbit and ephemeris computed by Hirst and Stoy:

Elements

T	1948 Oct. 27·460 U.T.	
ω	106° 00′	1948·0
Ω	209 44	
i	22 48	
q	0·1296	

Ephemeris

	0h. U.T.	
1948	α 1948·0	δ 1948·0
Nov. 14	12h. 37·4m.	−25° 53′
18	12 04·4	28 40
22	11 30·9	31 04
26	10 56·1	32 57

Announcements

THE following higher degrees have been conferred by the University of Aberdeen: Ph.D., on G. F. Walker, for a thesis on "The Clay Mineralogy of some Aberdeenshire Soils"; M.D., on H. McL. Raffan, for a thesis on "Poliomyelitis in Aberdeenshire".

ERRATUM. Dr. Oscar Hechter states that the reference in the communication "Spreading Phenomenon and Inflammation" (*Nature*, October 30, p. 701) to earlier work (par. 4) should be to footnote 1, and not footnote 2 as appeared in his manuscript.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Clinical Potentialities of Certain Bisquaternary Salts Causing Neuromuscular and Ganglionic Block

Two members of the polymethylene αω-bistrimethylammonium series[1] ($[N^+(CH_3)_3.(CH_2)_n.N^+(CH_3)_3]\ 2I^-$) appear to possess activities which may be suitable for clinical use—the C 10 derivative ($n = 10$) to produce neuromuscular block, the C 6 derivative ($n = 6$) to produce ganglionic block. We wish to describe briefly the main characteristics of these compounds, in view of the great attention being paid to possible substitutes for *d*-tubocurarine chloride[2,3] and to the use of tetraethylammonium iodide for ganglionic block[4].

The accompanying table gives the doses of C 10 and *d*-tubocurarine chloride which are approximately equipotent in causing neuromuscular block when injected intravenously into unanæsthetized monkeys (*Macaca mulatta*), cats and rabbits.

		Monkey	Cat	Rabbit
d-Tubocurarine chloride	(mgm./kgm.)	0·1	0·15	0·17
C 10 compound	(mgm./kgm.)	0·3	0·03	0·10

These results show variation of potency of the C 10 derivative of the bistrimethylammonium salt with species (as we previously reported); preliminary trials indicate that man is close to the cat in sensitivity. The onset of the paralysis is smooth and uneventful in the monkey and the cat; in the rabbit, transient fine fasciculations (of the type reported in the cat under chloralose[1]) are just detectable. In general, the order in which the various muscles are paralysed and recover from paralysis is much the same as with *d*-tubocurarine chloride.

The main difference between the C 10 compound and *d*-tubocurarine chloride lies in the relative sparing of the respiration by the former in the monkey and the cat. In the monkey, even a small dose of *d*-tubocurarine chloride (0·075 mgm./kgm.), sufficient to produce weakness for about ten minutes, is accompanied by exaggerated movements of the nostrils and trunk indicative of respiratory difficulty. Similar respiratory signs can only be produced by the C 10 compound under test with a dose of 0·5 mgm./kgm., which causes complete paralysis of the animal for ten minutes, and weakness for an hour. Similar observations have been made in unanæsthetized and anæsthetized cats, and (to a less extent) in the rabbit. The ratio of the dose which just suspends respiration in half the animals to that which produces definite weakness for at least 10 min. has been estimated, as an index of the relative activity on respiratory and other muscles. In the monkey, the ratio is 2·6 for the C 10 compound, and 1·5 for *d*-tubocurarine; in the cat, the ratios are respectively 2·2 and 1·25. In the rabbit we have not been able to demonstrate any significant difference by this method, the ratio in both cases being close to unity. It is also noteworthy that the duration in the monkey of a paralysis due to the C 10 compound is usually two to three times longer than that of one of equal initial intensity due to *d*-tubocurarine chloride.

Eserine and prostigmine do not antagonize the C 10 compound; but a lower member of the series, C 5, has proved to be a useful antagonist. In all three species, an injection of 0·5–5 mgm./kgm. of C 5 cuts short a moderate or shallow paralysis, accelerates recovery from a deep curarization, and restores to normal a respiration that is becoming inadequate, where these conditions are due to the C 10 compound.

The C 10 compound must be compared with *d*-tubocurarine chloride in two other respects: (*a*) the latter is active in paralysing autonomic ganglia, and may thereby cause a small fall in blood pressure; the former exhibits some activity of this kind, but requires a dose five to ten times as great to produce the same effect; (*b*) the latter is known to liberate histamine[5], and such liberation might cause undesirable side-effects; the former can also be shown to produce an effect on the blood pressure characteristic of histamine liberation[6]; but it requires a dose at least four times larger. We have confirmed Barlow and Ing's[7] finding that this series of compounds possesses a weak anti-esterase activity; but this activity does not appear to produce any side actions, except possibly the fine fasciculations in the rabbit mentioned above. Chronic toxicity tests have shown that rabbits and cats can receive curarizing doses of the C 10 compound daily for six weeks without change in type or degree of the paralysis, or deterioration in the health of the animal.

As a possible substitute for *d*-tubocurarine chloride, therefore, this C 10 compound merits consideration, since it is both potent and can be antagonized; it also has the following advantages: (1) it spares the respiration; (2) it has less ganglionic action; (3) it has less power of liberating histamine; (4) it is a simple compound easily synthesized.

The C 6 derivative possesses great potency in paralysing autonomic ganglia, although it is inactive in other respects except in very large doses. Its effects, when injected in a dose of 0·1–1 mgm./kgm., are closely similar to those of tetraethylammonium iodide (paralysis of contraction of cat's nictitating membrane excited by preganglionic stimulation; fall of blood pressure, no longer obtainable after a paralysing dose of nicotine; paralysis of peristaltic reflex of rabbit intestine; paralysis of parasympathetic ganglia of the heart), and have been shown to be restricted to the autonomic ganglia. C 6 differs from tetraethylammonium iodide in its greater potency (ten to twenty times, according to test object), and in its slower onset and three to four times greater duration of action.

The C 6 derivative, therefore, offers possibilities of clinical usefulness in such fields as hypertension and vascular disease, whenever tetraethylammonium iodide has too brief or slight an action.

Details of the pharmacological investigations will be published in full elsewhere.

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Tracer Phosphatase Determination in Tissue Sections

THE increasing use of radioactive tracers in biology demands methods for quantitative recording even in tissue sections. Autoradiography furnishes one method, either by simply placing the sections containing the radio-ions towards a photographic plate[1], or by covering the section itself with a film of photographic emulsion[2,3]. In this way α- and even β-rays can be recorded[4].

The Geiger – Müller counter, however, is still the best means for quantitative recording of β-rays. I have used a counter in the way described below to record the amounts of radioactive tracers in tissue sections as well as of tissue extracts according to established principles.

A Geiger – Müller counter, as described by Ambrosen, Madsen, Ottesen and Zerahn[5], is placed within a lead cylinder directly above an aluminium turntable with eight holes for small aluminium dishes which contain the radioactive material. The electrical details of the apparatus, which contains a regulated 2,000-volt power supply, a scale-of-16 and a scale-of-10, a registering device and an arrangement which makes it possible to make counts for each dish or slide automatically as long as desired within the limits of 2 minutes and 30 hours, has been described elsewhere[6].

When tissue sections are to be measured, they are mounted on polished slides and covered by a 'Cellophane' coverslip; the sections are placed above the holes in the turntable, and by means of a microscope fixed to the apparatus their positions are controlled. Small brass plates, 1 mm. thick, with diaphragms of the desired diameters, ½–2 mm., are then lowered upon the slides and are kept in place by means of small pins fitting into holes in the turntable. Before the plates are pressed into position, it is checked by the microscope that the desired parts of the sections actually are centred beneath the diaphragms.

Now the Geiger – Müller tube with its lead cylinder is raised 2 mm. by means of a half-moon-shaped piece of lead which corresponds to the height of the slide plus brass plate, and the counting may begin.

As the brass plate directly covers the section, except for the 0·05 mm. thick 'Cellophane' coverslip, the amount of tissue in which the radio-ions are measured depends only upon the diameter of the diaphragm and the thickness of the section. Using a common diaphragm of 1 mm.[2] and sections of 5 μ, the amount of tissue under observation is only 0·005 mgm. Either frozen sections or paraffin or celloidin sections, stained or unstained, may be used. When possible, stained sections are preferred, as the histological examination and the radio-ion counting can then be undertaken in the same section.

As an example of the method, I have made a quantitative estimation of phosphatase in tissue sections by means of a modified Gomori[7] technique. The tissue, fixed in 80 per cent alcohol and imbedded in paraffin wax melting at 42°, is cut in 10 μ sections which are deparaffinized and incubated in a substrate of glycerophosphate containing radiophosphorus and calcium nitrate. The sections, which now contain radioactive calcium phosphate, can then be placed directly in the apparatus, and afterwards—or previously—be stained with cobalt according to Gomori. The Gomori technique thus affords a qualitative, and the method mentioned here a quantitative, means of estimating phosphatase in the same section.

A further report of the results will appear in due course.

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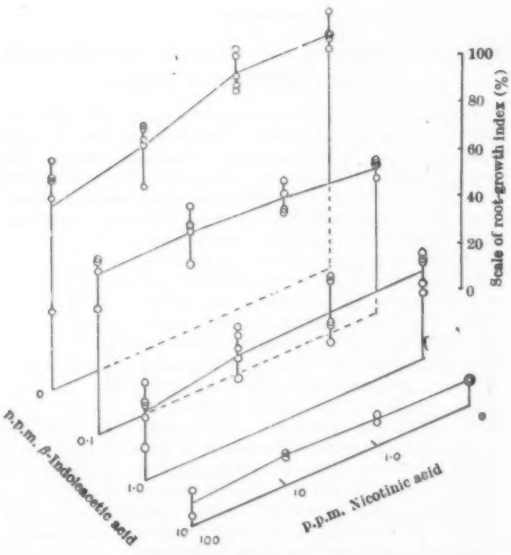
Nicotinic Acid and the Inhibition of Growth by Auxin

IN a recent paper, Galston[1] has shown that β-indoleacetic acid, at concentrations of 1–10 p.p.m., inhibits the growth in the dark of excised stem tips of *Asparagus*, in contrast to its normal stimulating effect in the light. Nicotinic acid, at a concentration of 0·5 p.p.m., was shown greatly to augment this dark inhibition, although without any effect by itself. These results were regarded as indicating that nicotinic acid is involved in the growth-regulating action of β-indoleacetic acid.

Recently, I have been studying the interactions with auxins of a wide range of plant metabolites in the growth inhibition of roots, and a considerable number of observations has been made with nicotinic acid. The technique employed has been fully described in a previous paper[2] and consists essentially of growing samples of cress seedlings in sterile water-culture in a number of different concentrations of the two substances both singly and in all possible combinations of those concentrations. Total root-



Three-dimensional diagram showing the interaction of nicotinic acid and β-indoleacetic acid in the growth-inhibition of cress roots

growth per seedling was determined by weighing the fresh excised roots at the end of the experiment (7–10 days growth) and expressed as a percentage of the controls in the pure culture medium (root-growth index). The seedlings were grown in normal daylight. The results of a number of experiments are collected in the accompanying three-dimensional diagram. The two basal axes represent a grid of the various combinations of concentrations of β-indoleacetic acid and nicotinic acid, while the vertical axis gives the relevant values of the root-growth index.

It will be seen that nicotinic acid by itself brings about slight growth inhibition at high concentrations, but is without significant effect in any of the β-indoleacetic acid concentrations. It is possible that nicotinic acid may itself be, or may give rise to, an inhibitor of the auxin type in these high concentrations; but its effect is not detectable in the presence of the much more active β-indoleacetic acid. There is certainly no indication of any synergistic effects of the two substances, and this suggests that the phenomenon observed by Galston is not of general occurrence.

It is pointless with such meagre data to attempt an explanation of the discrepancy between two such isolated observations; but the above results suggest that the experiments of Galston should be repeated on an organ in which the inhibiting action of auxins has been much more intensively studied, such as the root. It is hoped eventually to extend the above investigations to excised roots growing, as in the case of Galston's stem tips, on a purely synthetic medium.

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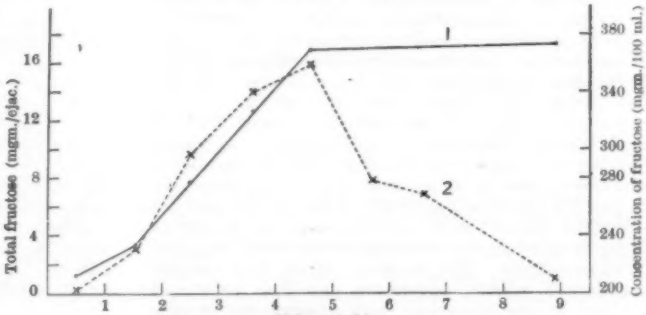
Relation between the Volume and Fructose Content of Human Semen

Estimations of fructose content, by the method described by Mann[1], have been carried out on 150 specimens of human semen, obtained from 123 individuals. Of these, 41 ejaculates were obtained from 31 men of proved fertility, the remainder from men whose marriages had been involuntarily childless.

Considerable variation was found both in the concentration of fructose and in the total fructose content of the ejaculate. The concentration varied from less than 5 mgm. to 640 mgm. per 100 ml., with a mean value of 287 mgm. per 100 ml., while the total fructose ranged from less than 0·05 mgm. to 31·6 mgm., with a mean of 9·37 mgm. per ejaculate. The semen with minimum concentration, and also minimum total fructose, came from a fertile donor, as did the specimen with maximum concentration. That with maximum total fructose came from a childless man with a sperm density persistently less than 1 million per ml. Apart from a notable excess of good specimens and of fertile donors in the fructose range 200–500 mgm. per 100 ml. semen, no significant correlation was found between seminal fructose level and either sperm density or motility. This is not surprising in view of Mann's finding that azoospermic bull semen can be very rich in fructose, and that fructose is a chemical compound characteristic of the seminal plasma but not of spermatozoa as such.

On the other hand, a very interesting relationship was found between the fructose content of the semen and the volume of the ejaculate. As shown in the accompanying graph, the average concentration of fructose increases with volume, at first gradually, and then more steeply up to a maximum of 360 mgm. per 100 ml. in specimens with a volume between 4 ml. and 5 ml. With further increase in volume the concentration falls, specimens more than 7 ml. in volume having an average concentration of 209 mgm. per 100 ml. The total fructose content of the ejaculate also increases with volume, below 2 ml. at the rate of 2 mgm. per ml., and between 2 ml. and 5 ml. at the rate of 4·5 mgm. per ml. Above 5 ml. there is no appreciable increase of fructose with volume. It appears that the fructose-bearing secretion contributes the greater part of the extra volume between 2 ml. and 5 ml.; but further increments in volume are almost entirely due to the activity of other glands. Assuming that the majority of the fructose is produced by the seminal vesicle, the variation in volume and fructose content found in different individuals may well be the result of the marked variation in size of the seminal vesicle in man.

The ejaculate with highest fructose content in this series contained 31·6 mgm. of fructose in 8 ml. of semen. The highest concentration found was 640 mgm. per 100 ml., in a specimen of 4·4 ml. volume, and total fructose content of 28·2 mgm. It would seem that the maximum fructose output of the human seminal vesicle is about 30 mgm. of fructose contained in about 4 ml. of fluid of concentration 700 mgm. per 100 ml. On this basis the proportion of vesicular to other secretions could be worked out for any specimen of semen, an average specimen of 4–5 ml. volume being approximately 50 per cent vesicular secretion, whereas the seminal vesicles contribute only 30 per cent of the fluid in specimens less than 2 ml. in volume. However, Huggins and Johnson[2] found that in fluid obtained from the seminal vesicles by massage per rectum the copper-reducing substances varied from 275 mgm. to 625 mgm. per 100 ml., and it cannot be assumed, therefore, that the composition of the seminal vesicle secretion is approximately constant in sugar content.



Curve 1, variation of total seminal fructose with volume of ejaculate; curve 2, concentration of fructose

The volume of an ejaculate is to some extent affected by the time since the previous emission, and, in particular, specimens produced after intervals of less than 24 hours tend to be exceptionally small. In the present series 23 (47 per cent) of the 49 specimens with a volume less than 2 ml. were produced after an interval of less than 24 hours since the previous ejaculate. If the semen specimens are grouped according to time since previous ejaculate, at intervals of 24 hours, the average concentration of fructose remains constant after the second day up to the eighth day, the longest interval for which sufficient specimens were available to give a reliable value. The total fructose increases during this period in proportion to volume at the rate of 2 mgm. per ml. increase in volume. The mean fructose value for specimens produced with less than two days interval since the previous ejaculate is 250 mgm. per 100 ml., compared with 300 mgm. for specimens produced after longer intervals. The rate of increase of fructose with volume during the first two days is 5 mgm. per ml. increase in volume. These results suggest that the seminal vesicle in man is depleted to a much greater extent by a single ejaculation than appears to be the case in certain domestic animals such as the bull and the ram, and that a period of about 48 hours is required before the contribution of the seminal vesicle to the semen plasma, and therefore its fructose content, reaches the value characteristic of the individual donor.

It follows from these results that the volume of the ejaculate and the interval since previous emission must be taken into account in any attempt to correlate fructose content with other seminal characteristics, or to use fructose content as a measure of testosterone activity in man. Clearly no specimen produced within two days of a previous ejaculate can be relied upon to give a proper measure of fructose content. When the characteristic concentration has been reached, each specimen must be considered in relation to the mean fructose content of specimens of similar volume.

I am indebted to Dr. T. Mann for his instruction in technique, and his unfailing interest. The work was carried out with the help of a grant from the Medical Research Council.

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Preservation of the Fertilizing Capacity of Bull Semen in the Genital Tract of the Cow

HEIFERS and cows with regular œstrous cycle were inseminated several hours (6–12 up to 48 hours) before the expected œstrus. The sperm used in these experiments was collected from the two bulls of the artificial insemination centre; it was diluted 1/50 in sodium citrate – egg yolk diluent and inseminated by rectal fixation of the cervix. In most of the cows the operation was executed very easily, and the insemination was made partly in the corpus uteri and partly in the cervix; exceptionally the cervix is insufficiently dilated, but penetration with the catheter was possible though more difficult than in the heat-period.

The beginning and the end of heat were noted by the owner; we did not control by rectal examination the exact moment of ovulation for fear of damaging the follicle; but we believe that ovulation takes place 10 hours after the end of heat in heifers and 16 hours in cows (Hammond).

In three of thirteen inseminated animals, the expected œstrus did not appear during the first days after insemination. Of the remaining ten animals, four returned in heat and were not pregnant; two of them were inseminated about 48 hours before œstrus; six animals (four heifers and two cows) became pregnant, which corresponds to the conception-rate for artificial insemination during the heat-period. Of these six animals, two were inseminated nearly 51 hours before ovulation, three were inseminated 45 hours before ovulation, and one was inseminated about 40 hours before ovulation.

Further experiments are going on with a larger number of cows; but these results seem to indicate that the sperm of fertile bulls, diluted with sodium citrate – egg yolk diluent and inseminated deeply in the cervix and the corpus uteri, may keep its fertilizing capacity completely undamaged in the genital tract of the female at least up to 50 hours, even when this sperm has been stored for three days in the refrigerator.

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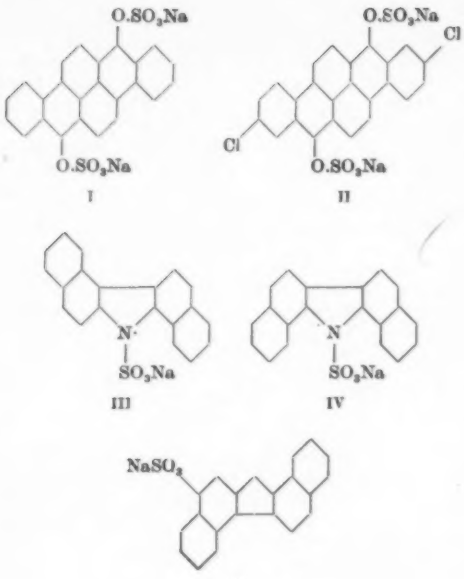
Inhibition of some Respiratory Enzyme Systems by Derivatives of Sulphuric Acid

IN the course of work primarily concerned with the biological action of carcinogens, it was found that various sulphuric acid derivatives of large-molecule hydrocarbons strikingly inhibited certain enzyme systems when tested in Warburg respirometers. Substances I, II, III and IV (see over) inhibited the pyruvate-triose-phosphate system of rabbit skeletal muscle[1] by 87, 95, 94 and 50 per cent respectively, and the oxaloacetate-triosephosphate system of the same preparation by 68, 70, 53 and 10 per cent when added at $M/500$ in presence of 1/150 per cent extra cozymase. With extra cozymase the inhibition was decreased. It appeared to be competitive. Substance V was almost inactive at this concentration.

The first four compounds also inhibited the oxidation of lactate by ferricyanide[2] in presence of the Straub[3] lactic apodehydrogenase of bullock's heart muscle. The four inhibitors at $M/10{,}000$ in presence of 1/150 per cent added cozymase caused losses in activity of 52, 88, 20 and 21 per cent respectively. This effect was also diminished by extra cozymase. Substance V was again inactive.

The first four compounds at $M/7{,}500$ also inhibited the oxygen uptake of a rabbit-liver homogenate in presence of succinate by 71, 70, 21 and 34 per cent respectively. Sodium methyl sulphate, sodium methane sulphonate and sodium α-naphthalene sulphonate gave no inhibition even at $M/300$.



It appears that the inhibitory activity may be primarily attributable to the presence of an O—SO_3Na or N—SO_3Na grouping (in the cozymase systems the action of substance II being possibly potentiated by the presence of two chlorine atoms in the molecule). On the other hand, the grouping C—SO_3Na seems to be inactive. The mode of action of the active compounds may be either direct competition with cozymase or some reaction entailing fission of the active groupings in the manner postulated by Crabtree[4] for chlorcompounds.

My thanks are due to I.C.I. (Dyestuffs), Ltd., for gifts of chemicals.

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Enzymatic Degradation of Ribonucleoproteins of Chromosomes, Nucleoli and Cytoplasm

IN experiments utilizing purified crystalline ribonuclease in conjunction with various staining procedures, it has been possible to demonstrate that chromosomes of higher plants and animals contain appreciable quantities of nucleic acid of the ribose type. These experiments have also shown that ribonuclease may hydrolyse ribonucleoprotein, and that the residual material (non-histone protein) can be digested by pepsin. Conversely, ribonucleoprotein may be hydrolysed by pepsin, and the residual material (ribonucleic acid) degraded by ribonuclease. Such combination treatments have provided information concerning the localization of ribonucleoproteins, ribonucleic acid and non-histone proteins in nucleus and cytoplasm. The validity of these methods for diagnostic purposes rests upon the use of highly purified and carefully assayed enzymes, and the employment of an adequate series of controls to determine the influence of variables capable of modifying the histochemical reactions.

Results obtained by treating root-tip cells of onion and lily and salivary-gland cells of *Drosophila* serve to illustrate the potentialities of histochemical methods utilizing enzymatic hydrolysis. When sections or smears of these materials fixed in acetic alcohol are stained with Unna's methyl green – pyronin combination, the chromosomes are blue-lavender, the nucleoli and cytoplasm red. If hydrolysis by ribonuclease precedes staining, however, no component remains that colours with pyronin[1], so that cytoplasm and nucleoli are colourless and the chromosomes green. The possibility, inherent in earlier experiments of this type[2,3], that reduction in stainability might be referable to removal of proteins by protease-contaminated ribonuclease[4] has been obviated in these studies by the use of preparations of ribonuclease that are free from all measurable traces of proteolytic activity[5]. It can be concluded, therefore, that ribonucleic acid is present in chromosomes as well as in cytoplasm and nucleoli. Additional evidence leading to the same conclusion has been provided by the preparation of ribonucleoprotein from isolated chromosomes[6].

The use of fixatives particularly suitable for cytological studies, such as the fluids of Flemming and Navashin, makes possible staining procedures which cannot be used advantageously following fixation in acetic-alcohol. Thus the safranin – gentian violet – orange *G* triple stain, when used after the chrom – osmic – acetic acid fixatives, permits a pattern of differentiation in meristematic cells of root tips in which metaphase and anaphase chromosomes are bright red whereas the chromonematic threads of late telophases and early prophases are violet. Ribonuclease attacks this red-staining component, so that metaphase and anaphase chromosomes appear violet after hydrolysis. Prolonged treatment with ribonuclease also impairs stainability with the gentian violet component of the triple stain. These observations suggest that the ribonucleic acid of condensed chromosomes may be present in more than one form, and that there occurs in the course of mitosis a cycle of accretion and dispersion of chromosomal ribonucleic acid which may be correlated with the appearance and disappearance of the nucleolus, and which is presumably related to the control of genic activity.

Flemming's triple stain has also provided a clue to the localization of the non-histone or tryptophane-containing protein[7,8]. It was found that cytoplasm, chromosomes and nucleolus, after treatment with ribonuclease, show a density and brilliance of coloration with orange *G* that is not detectable in the controls. A similar colour intensification may also be obtained with other acidic dyes, such as acid fuchsin, light green and fast green. Thus, if sections are treated with ribonuclease and stained with fast green (using the Feulgen reaction for desoxyribonucleic acid to provide contrasting colour in the chromosomes), they will show an over-all intense and vivid green as compared with the pale green of undigested controls; but if the treatment with ribonuclease is followed by one with pepsin, the amount of green colour is then much less than that of the

controls. Similar results are obtained when the nucleic acid is removed by Schneider's trichloracetic acid treatment[9]. These results indicate that ribonuclease can digest ribonucleoprotein, and that the protein thus freed stains intensely with acidic dyes and can be degraded by pepsin. Digestibility by pepsin suggests that this stainable material is non-histone protein[10]; its distribution within the cell, moreover, parallels that of tryptophane-containing material as determined by histochemical application of Bates' modification of the May – Rose test[1].

Ribonucleoprotein may be degraded by pepsin as well as by ribonuclease. If sections are treated with pepsin and stained in Unna's pyronin – methyl green combination, chromosomes, nucleoli and cytoplasm of the hydrolysed cells stain more intensely with pyronin than do those of unhydrolysed controls. If sections are treated successively with pepsin and ribonuclease, chromosomes, cytoplasm and nucleoli no longer stain red, indicating that the nuclease has removed the pyronin-avid material. These experiments indicate that ribonucleic acid may be present in fixed cells either free or combined as ribonucleoprotein, and that its stainability with pyronin is influenced by the state of association.

Such treatments, using combinations of enzymes, thus serve as a guide to an understanding of the affinity of certain dyes for specific cellular components. Other combinations of enzymes and dyes have been utilized in the study of a variety of normal and aberrant types of plant and animal cells. A detailed account of these studies will be presented in other publications.

Progress of this study has been facilitated by a grant from the United States Public Health Service, National Institute of Health, Bethesda, Maryland.

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Giant Binary Stars and the Mass-Luminosity Law

IT is well known that spectroscopic parallaxes are an index of stellar surface gravity, which in turn is functionally related to the mass and luminosity of a star. If, therefore, there exists a class of stars in which this functional relation differs from that found for the majority of stars, we should expect a lack of agreement of the mean trigonometric, dynamic and spectroscopic parallaxes of these stars.

In "The Masses of the Stars", Russell and Moore[1] directed attention to a serious discrepancy between the trigonometric and spectroscopic parallaxes of 52 visual binaries of the giant sequence. It is especially significant in view of the very excellent agreement of these parallaxes found for 641 *single* stars of the giant sequence. For the latter, the 'reduced' trigonometric and spectroscopic parallaxes are 0·0988″ and 0·0985″, respectively, whereas for the 52 double stars the corresponding values are 0·063″ and 0·095″.

The agreement of the spectroscopic parallaxes of the single and double stars is a strong indication that the surface conditions of these stars are, as a whole, identical. One is led to suspect a systematic error in the trigonometric parallaxes, yet none is obvious; none exists for double stars of the main sequence, and the discrepancy noted by Russell and Moore is not related to the separation or relative brightness of the components of the double star.

Acceptance of the trigonometric values places these stars about a magnitude above the regular giant sequence and, according to Russell, indicates a mass of about double that of single giant stars (mass-luminosity law). It is of particular interest that the increased mass would in this case be compensated almost exactly by the increased radius necessary to account for the greater luminosity, thus leaving the surface gravity unchanged. The giant binaries, then, would at once be over-luminous for their spectral class, sub-luminous for their mass, but of unchanged surface gravity. The observed agreement of the spectroscopic parallaxes of the single and double stars would thus be explained.

In view of the apparent failure of the mass-luminosity law in giant binaries, it is of interest to consider also the dynamic parallaxes of these stars, and secondly, to find whether the parallax discrepancy found for visual pairs exists also for spectroscopic binaries and for very wide common-proper-motion pairs.

The appeal to dynamic parallaxes is of special interest, for if giant binaries are sub-luminous for their masses, dynamical parallaxes derived for these stars should be somewhat greater than their trigonometric parallaxes, yet considerably smaller, numerically, than their spectroscopic values. This is observed to be the case: for 64 pairs for which trigonometric dynamic and spectroscopic parallaxes were available, the reduced values of these quantities are 0·065″, 0·075″ and 0·104″, respectively. Again, for 103 pairs for which dynamic and spectroscopic parallaxes were available, the respective values were 0·088″ and 0·114″. This latter discrepancy is, of course, totally independent of any possible error in the trigonometric parallaxes. No corresponding discordance occurs for main sequence pairs.

Spectroscopic binaries were also found to exhibit the discordance found for visual pairs: for 47 spectroscopic binaries, the mean reduced trigonometric and spectroscopic parallaxes were 0·079″ and 0·100″, respectively. However, for 34 very wide common-proper-motion pairs, excellent agreement in the mean for these parallaxes was found, thus perhaps relating these stars more closely to the single stars than to the closer doubles. That this agreement argues for a systematic error in the trigonometric parallaxes is not supported by the fact that in the closer pairs, for the most part, the components were far too faint, and of too long a period of revolution, to affect the measured parallaxes.

We can conclude, then, that the mean observed values of the trigonometric, dynamic and spectroscopic parallaxes of giant binaries are consistent with the hypothesis that these stars (the primary components)

lie above the ordinary giant sequence but are subluminous for their masses.

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April 15.

[1] Russell, H. N., and Moore, C. F., "The Masses of the Stars" (University of Chicago Press, 1940).

Mixed Types of Stellar Populations

ONE of the most interesting and most mysterious features of the stellar contents of our own and other known galaxies is the fact that there seem to exist two rather distinct types of stellar populations differing between themselves by mechanical as well as by physical properties of individual members. In fact, as was first indicated by Oort[1], the so-called 'high-velocity' stars which describe highly elongated elliptic trajectories around the galactic centre seem to possess rather different physical characteristics as compared with the 'ordinary' stars predominating in the neighbourhood of our sun and moving along regular, almost circular, orbits. This distinction was amplified by the recent work of Baade[2], who has shown that the ordinary type of stellar population (which he calls type I) is characteristic only for the region of spiral arms, whereas the other type (type II) forms the structure of the galactic nucleus along with the tenuous, almost spherical, 'atmosphere' surrounding the entire system. All elliptical and spherical galaxies seem to be formed entirely from stars of type II.

The physical differences between the two stellar populations, as evidenced by the study of the corresponding Hertzsprung – Russell diagrams, can be summarized as follows: (1) the giant branch of the main sequences is completely absent in stellar population II; (2) the red giants of population II are different from those in population I, and are distributed along a continuous band which starts from the middle of the main sequence (the upper part of which is absent in this case) and is about one to three magnitudes above the ordinary red giant branch of population I; the number of type II red giants (relative to the number of dwarfs of the same spectral clan) is smaller in type II as compared with type I; (3) the lower part of the main sequence seems to be identical in both populations.

It has been also noticed that the percentage of double stars is two to three times lower among the stars of type II.

The understanding of physical differences between the two types of stellar population, and their relation to the difference of their motion and distribution within the galactic system, will undoubtedly throw much light on the general problem of stellar and galactic evolution. It is, therefore, especially annoying that hitherto we have not had any reliable theory of the internal structure of red giant stars capable of representing one of the principal differences between two types of stellar populations. For the same reason it is extremely important to collect all possible information concerning these stars and their possible relation to one of the two accepted types.

The results published by Dr. Hynek in the preceding letter seem to permit some interesting, though highly hypothetical, conclusions in this direction. Whatever may be the model on which the ordinary red giant stars are built, it seems very improbable that it could lead to the mass-luminosity relation, in which the doubling of the mass will increase the luminosity only by a factor of two. In fact, thermonuclear reactions which are responsible for the entire energy balance of the star must be expected to be much more sensitive to the internal temperature changes which would result from the larger total mass of the star. It seems, therefore, more reasonable to assume that the observed difference between the single red giants and those which are the members of a pair must be connected with the difference of their chemical constitution, their internal structure (model), or both. Since the same assumption must also probably be made to understand the difference between red giants of the types I and II, we could ask ourselves whether it is at all impossible to explain the facts stated by Dr. Hynek by assuming that red giants in the binary systems are essentially the stars belonging to the stellar population II? Indeed, the mean luminosity difference of about one magnitude between the single and double giants is comparable with the mean difference between the red branches of the two populations. Also the discrepancies between the spectroscopic and trigonometric parallaxes of single and double red giants which led Dr. Hynek to his conclusions are similar to the discrepancies observed by Morgan and Keenan[3] in the case of 'high-velocity' stars, inasmuch as they state that "high-velocity stars appear to be the only stars likely to cause serious trouble in using the method of spectroscopic parallaxes".

It must be remembered, however, that the binaries studied by Russell and Moore and by Hynek are, as a rule, the ordinary slow-moving stars which would be classed normally as type I. Thus, in making the above statement, we would be forced to accept the possibility of a mixed type of stars (type II_I) which possess the physical characteristics of type II but the motion of the type I. There may be also stars (type I_{II}) which look like those of type I but move as type II. Remembering that the correlation between physical properties and the type of motion of any individual star must be due to some events in the early history of its existence (formation process), and that the motion (as well as the family status) of a star may be changed by a number of external causes, such an assumption does not look at all unreasonable.

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May 4.

[1] Oort, T. H., *Groningen Pub.*, No. 40 (1926).
[2] Baade, W., *Astrophys. J.*, **100**, 137 (1944).
[3] Morgan, W. W., and Keenan, P. C., "An Atlas of Stellar Spectra" (Astrophysical Monographs) (Chicago, 1943).

New Localized Interference Fringes

IN this note a description is given of a simple method for producing a new type of sharp localized interference fringes with interesting properties. These sharp fringes are best formed by multiple-beam interference, although a broadened variant can be obtained with two beams. They arise when a plane parallel sheet of flexible material silvered on both sides is bent into a curve (suitable radii of curvature are 1–5 cm.) and illuminated with strictly parallel monochromatic light from a point source, such collimation of light being essential. The simplest

procedure is to flex a thin slip of doubly silvered mica into a cylindrical shape. In such a case straight-line fringes somewhat resembling those of a Lummer plate are the result. If the thin film is in the form of a spherical shell (for example, a blown thin film of glass) circular fringes form, resembling Fabry–Perot rings. Under suitable conditions, the fringes are critically localized and appear on a screen suitably placed. Both the mode of formation and the plane of localization are indicated by Fig. 1, where, for simplicity, refraction effects are disregarded. The detailed theory will be published elsewhere, and main conclusions only are given here.

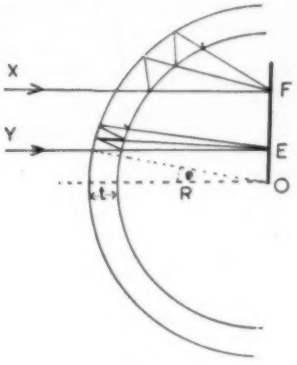

Fig. 1

Let parallel monochromatic light be incident from the left and let O be the centre of curvature. An incident ray Y is partly transmitted and partly reflected, and the successive beams all intersect at E. The multiply-reflected rays have a path difference $n\lambda = 2\mu t \cos\theta$, and at E, if the reflectivity is high, there is formed a sharp localized interference fringe with effectively an Airy intensity distribution, providing high values of θ, and small values of radius of curvature are employed.

In like manner, another incident ray X produces a fringe at F. Detailed analysis shows that a succession of fringes is localized nearly on the line OF, which is perpendicular to the direction of incidence. As in the Fabry–Perot interferometer analogue, the fringe 'radii' are here approximately proportional to the roots of the natural numbers, the diameter of the nth ring being approximately given by $2R\sqrt{\lambda(\varepsilon+p-1)/t}$, in which R is the radius of curvature, t the film thickness, ε the fractional order of interference at the centre and λ the wave-length.

An example of the fringes so obtained is shown in Fig. 2, which are transmission fringes from cylindrically bent mica. They can be seen either on a ground-glass screen placed in the plane OF or with a lens focused on this plane.

Attention may be directed to the following features:

(1) Extreme sharpness, due partly to the high angle of incidence improving the effective reflecting coefficient.

(2) These particular fringes are double, the doubling depending on direction. This is due to birefringence of the mica, the doublet fringes which emerge being plane polarized, mutually perpendicularly, although non-polarized incident light is used. In Fig. 2 the centre of the system is at A.

Fig. 2

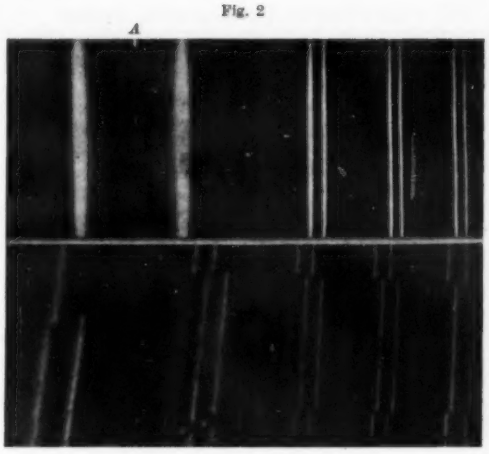

Fig. 3

(3) Under suitable conditions, that is, correct flexure of the specimen, two directions are found in which there is no birefringent doubling.

(4) Cleavage steps in the mica. These reveal their presence, and precision measurements on steps can be made, an example of such steps being shown in Fig. 3.

The fringes can be formed both by transmission and by reflexion. In the latter, tolerably sharp outer fringes are given by *unsilvered* films, because of the increase in reflecting coefficient at the higher angles of incidence. When silvered surfaces are used, the outer transmission fringes (higher angles of incidence) show additional complexity due to differential phase change effects, which lead to alteration in the birefringence doubling separation. Although a detailed analysis of the properties of the fringes in general, using both isotropic and crystalline media, is being communicated elsewhere, we suggest here a name to describe this new interference. It is proposed to describe the fringes as 'fringes of equal tangential inclination'. This is a fitting nomenclature since each fringe originates at the locus of points at which the incident rays all make the same angle with the tangents at the points of entry. The proposed name fits aptly into the accepted classical terminology for the other two types of fringes formed by a thin film with monochromatic light already long recognized, namely, the fringes of equal inclination and the fringes of equal thickness.

It may be noted that these precisely localized, sharp fringes, given here by a strictly parallel incident beam which suffers multiple reflexions, differ entirely both as to character and localization from the broad, confused, expanding, non-localized, elliptical fringes obtained by Raman and Rajagopalan with a widely diverging beam and a piece of unsilvered bent mica[1].

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[1] See *J. Opt. Soc. Amer.*, **29**, 413 (1939), and *Proc. Ind. Acad. Sci.*, **10**, 317 (1939).

Low-Level Atmospheric Ducts

During 1943–46, the Signals Research and Development Establishment operated a series of experimental centimetre-wave radio links along a 60-mile oversea path across Cardigan Bay. One major purpose of the investigation, which was carried out for an inter-Service committee under the chairmanship of Sir Edward Appleton, was to determine the degree to which meteorological factors affected microwave propagation and to find out to what extent the performance of such links could be predicted from synoptic data.

In addition to the taking of continuous records of radio field-strengths, frequent measurements were made of temperature, pressure, humidity and wind velocity at the two terminal stations at Strumble Head in South Wales and Aberdaron in North Wales. We have found a fairly definite correlation between the radio field-strength and the difference between air and sea temperatures, particularly when this difference was large, for the lowest link, in which the transmitting and receiving aerials were each about 100 ft. above sea-level. Figs. 1 and 2 show the results obtained on a wave-length of 9 cm. for those periods during the twelve months from July 1945 to June 1946 when the difference between the air and sea temperatures was greater than 5° F. It will be seen from Fig. 1 that when the air temperature was more than 5° F. lower than that of the sea, a condition which obtained mainly on cold days, the field-strength usually lay between 20 and 30 decibels below the free-space value. When, however, on warm days the air temperature was more than 5° F. higher than that of the sea, the field-strength was approximately equal to the free-space value. These two field-strengths, corresponding to cold and warm days respectively, although differing appreciably, are both well above the field-strength of 70 decibels below the free-space value which would be expected on the assumption of standard atmospheric conditions for this link, which was 2·3 times the optical range.

A study of the radio results according to modern radio-meteorological theory[1] suggests that the high field-strengths in Figs. 1 and 2 are due in both cases to the presence of so-called atmospheric ducts lying directly on the sea surface. For the conditions corresponding to those in Fig. 1, the heights of the ducts appear to vary between 20 ft. and 50 ft., while for the higher field-strengths in Fig. 2 the duct heights are greater and lie between 80 ft. and 120 ft. The ducts which give rise to these high field-strengths are due singly or to a combination of a temperature inversion and a rapid decrease with height in the water-vapour pressure in the atmosphere. The presence of the low ducts of 20–50 ft. when the air (at 100 ft. above sea level) is colder than the sea is not easy to explain. It was noted that the cold conditions giving rise to these particularly low ducts were associated frequently with high wind when, incidentally, the radio signal was found to be particularly steady. We would suggest that these ducts may be due to the presence of sea spray whipped up by the wind, either directly as constituting an increase in the water content in the lowest air strata, or indirectly as a means by which evaporation is assisted in these strata by the presence of the spray. The atmospheric moisture required to form the higher ducts necessary to satisfy the field-strength values in Fig. 2 during warm weather can be explained by evaporation from the relatively cold sea.

This relation between the radio field-strength and the difference between air and sea temperatures was studied first by Mr. H. Jarkowski, when he was in charge of the running of the Welsh stations. We regret that as he is now in Poland his name cannot be added to this note without causing undue delay. We are indebted to the Chief Scientist, Ministry of Supply, for granting permission to publish this note.

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B. Starnecki

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Ministry of Supply,
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June 14.

[1] Hartree, D. R., Michel, J. G. L., and Nicholson, Phyllis, "Meteorological Factors in Radio-Wave Propagation", 127–168 (London: Physical Society).

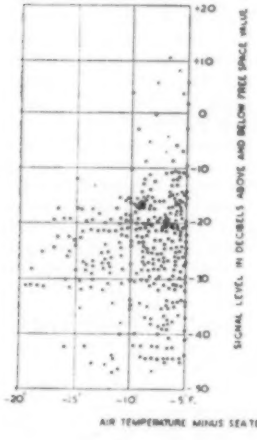

Fig. 1

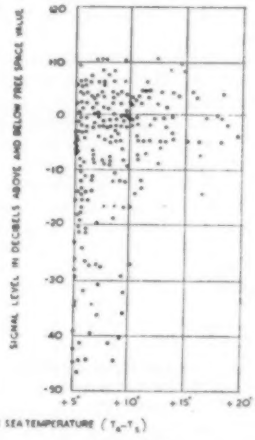

Fig. 2

Elastic Constants of Alum Determined by a New Ultrasonic Method

Following our work on the diffraction of light by ultrasonic waves in glasses described in an earlier communication[1], we have now obtained similar patterns in crystalline media, thus enabling us to devise a new method for determining the elastic constants.

Transparent and flawless specimens are suitably cut and polished, and stationary sound waves are maintained along specific directions of propagation. In cubic crystals, the cube and the octahedral axes are the most suitable. An X-cut or a Y-cut quartz plate is cemented on the surface of the polished prism according as it is desired to send longitudinal or transverse sound waves respectively. The sound velocities are then determined in each case in the usual manner by photographing the diffraction patterns at known frequencies. The effective elastic constants for specific directions are then calculated and the principal values deduced. Results obtained for alum along with those reported earlier by Voigt[2] and by Sundara Rao[3] employing other methods are given below in units of 10^{11} dynes/cm.^{2}.

	C_{11}	C_{12}	C_{44}
Authors	2·54	1·07	0·84
Voigt	2·43	1·009	0·843
Rao	2·56	1·07	0·86

As the measurements involved are of simple lengths, a high degree of accuracy can be obtained in this method by employing frequencies greater than 30 Mc./sec. The method is capable of being extended to a study of the dependence of elastic constants on temperature. Each crystal has, however, to be cut and polished to a high degree of perfection for a successful application of the method.

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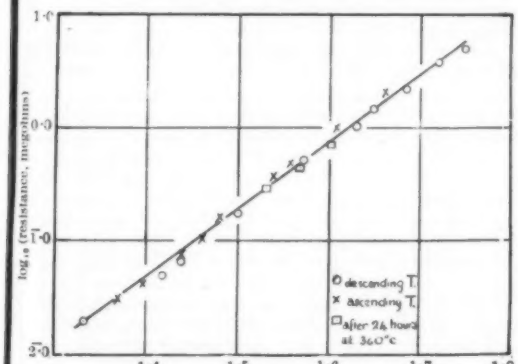
Nature, **159**, 742 (1947).
Gött. Nach., **1**, 85 (1918).
Current Science, **16**, 91 (1947).

Phthalocyanines as Semiconductors

In recent years Szent-Györgyi has directed attention to the possible importance of the electrical properties of organic molecules in biochemical catalysis[1] and has given evidence for photoconductivity in gelatin[2]. An approach to the theory in trans-conjugated polyenes has been indicated by N. S. Bayliss[3]. Hoping to obtain a system suitable for quantitative investigation, I have examined the electrical conductivity of two phthalocyanines. These substances, described by Linstead and co-workers[4], form a group of conjugated structures closely related to the biologically important porphyrins. They are particularly suitable for a research of this kind, because of their high degree of involatility and thermal stability. Their crystal structures are known from the work of J. M. Robertson[5].

Crystals of metal-free phthalocyanine and its derivative, copper phthalocyanine, have been examined in a 'Hysil' conductivity cell between platinum electrodes of area 2 sq. cm. separated by 2 mm. approximately. The crystals as packed in the cell had a bulk density of about 0·2. Hydrogen was circulated through the cell and its resistance measured as a function of temperature with a 'Megger'.

Both phthalocyanine and copper phthalocyanine have been found to be semiconductors. The accompanying graph shows the results for sample 1, I.C.I. metal-free phthalocyanine purified by sublimation *in vacuo*. It is clear that the results fit the well-known formula, $\rho = \rho_0 \exp E/RT$, where ρ is the resistance, R the gas constant, and E an 'activation energy'. The curve was quite reversible, and the sample was unaffected by 24 hours heating in hydrogen.



Resistance of metal-free phthalocyanine

Table 1. Metal-free phthalocyanine

Sample	$\log_{10} \rho_0$ (megohms)	E, k.cal.
(1) I.C.I., sublimed *in vacuo*	$\bar{1}$·24	27·6
(2) ,, ,,	$\bar{1}$·47	27·6
(3) I.C.I., sublimed in nitrogen	$\bar{1}$·08	29
(4) From Prof. R. P. Linstead	$\bar{1}$·35	27·6

Table 1 shows values of ρ_0 and E for four separate samples. The relatively small differences may be attributed to differences in the size of crystals and their packing in the conductance cell. It is very unlikely, in view of this reproducibility, that the semiconductivity of metal-free phthalocyanine arises from impurity centres. Metal-free phthalocyanine would appear to be an intrinsic semiconductor[6].

Two specimens of copper phthalocyanine were found to give qualitatively similar behaviour to metal-free phthalocyanine. However, both specimens showed some decrease in resistance and activation energy on heating in hydrogen at about 400° C. After twenty-four hours of such treatment a moderately steady state appeared to be reached, although a little hysteresis was still to be noted on the $\log_{10} \rho$ *vs.* $1/T$ curve, between values for ascending and descending temperature. The data in this state are summarized in Table 2.

Table 2. Copper phthalocyanine

Sample	$\log_{10} \rho_0$	E, k.cal.
I.C., sublimed *in vacuo*	$\bar{1}$·04	29·4
From Prof. R. P. Linstead	$\bar{7}$·1	20·7

While copper phthalocyanine does *not* require heat treatment to show semiconductivity, such treatment does have a modifying effect, and the two samples show quantitatively different behaviour. It is possible that impurity centres play a part here.

Considering the simple case of metal-free phthalocyanine, we may suppose that the electrons lie in energy-bands common to the whole crystal, arising perhaps by intermolecular overlap of the π-orbitals of the porphyrin rings. The observed activation energy of 28 k.cal. is then one half the energy gap between the full ground-band and the empty first excited band[7].

My thanks are due to I.C.I. (Dyestuffs Division), Ltd., and Prof. R. P. Linstead for the gift of specimens.

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[1] Szent-Györgyi, A., *Nature*, **148**, 157 (1941); "Chemistry of Muscular Contraction" (Academic Press, New York, 1947).
[2] Szent-Györgyi, A., *Nature*, **157**, 875 (1946).
[3] Bayliss, N. S., *J. Chem. Phys.*, **16**, 287 (1948).
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[5] Robertson, J. M., *J. Chem. Soc.*, 615 (1935); 1195 (1936); 219 (1937); *Ann. Rep. Chem. Soc.*, **37**, 188 (1940).
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Utilization of Wheat Bran for Streptomycin Production by *S. griseus*

THE study of the nutritive requirements of *Streptomyces griseus* has assumed great importance on account of the remarkable activity of streptomycin against a number of bacterial infections. A number of media in which successful antibiotic production takes place have been recorded in the literature[1–5]. During the course of investigations on streptomycin production, aqueous extracts of wheat bran were found to give encouraging results; the methods of preparation and composition of the extract are described elsewhere[6]. By the procedure employed, about 4,000 ml. of the extract with about 3 per cent total solid content can be prepared from 1,000 gm. of bran.

The experimental procedure adopted was the one described previously[6]. The total solids of the media were adjusted to 0·5, 1·0, 2·0 and 3·0 gm. per 100 ml., and the *p*H to 6·5–7. A Waksman's strain of the organism was used. Daily observations of the antibiotic contents and the change in the reaction of the culture fluids were made (see Table 1).

Table 1

Total solids in medium	Reaction of medium						Streptomycin in μgm. per ml. days					
	3	4	5	6	7	8	3	4	5	6	7	8
0·5 gm./100 ml.	6·9	7·3	7·4	7·6	7·9	7·9	29	36	98	89	85	78
1·0 ,,	7·1	7·4	7·6	7·7	7·9	7·9	29	35	108	110	108	99
2·0 ,,	7·1	7·2	7·6	7·7	7·9	7·9	32	69	111	114	109	92
3·0 ,,	6·9	7·2	7·4	7·6	7·8	7·9	25	32	69	93	117	103

These data show that good production of antibiotic takes place even when the total solids in the medium are reduced to about 1·0 gm. per 100 ml. Further, 1,500–2,000 μgm. of streptomycin is formed for each gram of the bran used.

Different additions in the form of minerals, nitrogenous and carbonaceous material were then made to the basal wheat bran extract medium and their effect on antibiotic production was studied. Addition of small amounts of sodium chloride to the media increased the antibiotic production, as may be seen from Table 2.

Table 2

Composition of medium		Streptomycin in μgm. per ml. (days after seeding)						
Wheat bran extract	Sodium chloride	2	3	4	5	6	7	8
100 c.c. containing 1 gm. of total solids	0·5 gm.	75	126	160	95	73	68	63
	1·0 ,,	66	148	178	93	88	82	77
	2·0 ,,	46	161	163	98	98	83	82
	4·0 ,,	15	73	78	58	53	43	32
	5·0 ,,	15	40	78	70	65	45	33
100 c.c. containing 2 gm. of total solids	0·5 gm.	40	189	159	137	108	95	86
	1·0 ,,	52	179	203	138	123	86	76
	2·0 ,,	45	169	98	89	75	68	58
	4·0 ,,	23	85	93	93	60	54	33
	5·0 ,,	15	18	45	52	53	33	35

Concentrations of about 1 per cent appear to be the optimum. Higher ones are definitely harmful. In a medium containing sodium chloride, the antibiotic production is not only increased but also quickened. Observations of a similar nature regarding the role of sodium chloride have been recorded by Cook *et al.*[7] for penicillin production in pea extracts, and by Reke *et al.*[4] for streptomycin formation in soya-bean meal medium.

Wheat bran thus appears to serve as a cheap raw material for streptomycin production. Results of detailed investigations on these studies will be recorded elsewhere.

My thanks are due to Dr. K. M. Pandalai for helpful suggestions, to Prof. V. Subrahmanyan for his interest, and to Merck and Co., Rahway, N.J., for the standard streptomycin kindly supplied by them. I also acknowledge the financial support of the Council for Scientific and Industrial Research, India.

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[1] Waksman, S. A., and Schatz, *J. Amer. Pharm. Assoc.*, **34**, 273 (1945).
[2] LePage, G. A., and Campbell, E., *J. Biol. Chem.*, **152**, 163 (1946).
[3] Raghunandana Rao, R., *et al.*, *Nature*, **158**, 23 (1946).
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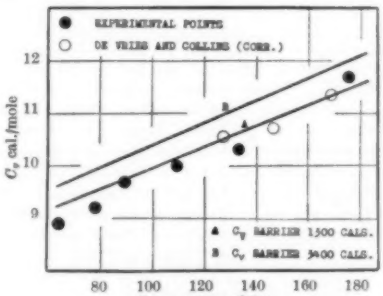
Heat Capacity of Methanol Vapour

CRAWFORD[1] has directed attention to a discrepancy between values assigned to the height of the energy barrier restricting the internal rotation in methanol. Such rotation is infra-red active, and spectroscopists have inferred that the barrier is 1,300 cal./mole. This would require the entropy at 25° C. and one atmosphere to be 57·62 E.U., while the observed value is 56·63 ± 0·25 E.U. Crawford pointed out that the discrepancy would disappear if the barrier were 3,400 cal./mole.

Independent information about the height of the barrier may be obtained from the heat capacity of the vapour. There is only one modern calorimetric measurement[2]. No attempt was made to correct for deviations from the gas-laws, and the results show an anomalous rise below 120° C. which was attributed to a dimerization of the vapour. New measurements of the heat capacity have been made between 64° and 176° C. by measuring the velocity of supersonic waves of frequencies 570 and 1,200 kc./s. The apparatus was that of Alexander and Lambert[3]. No dispersion of the sound was observed, the absorption was negligible and the observed value of the heat capacity was the same at each frequency. Under these conditions, the method is reliable (cf. Telfair[4]). At each temperature measurements were made over a range of pressure, and the 'ideal velocity' found by extrapolation to zero pressure. The results are, therefore, independent of any assumptions about the equation of state of the vapour.

The accompanying diagram shows both the experimental points and the values of the heat capacity



Heat capacity of methanol vapour

corresponding to barrier heights of 1,300 and 3,400 cal./mole. The latter were calculated by using the vibrational assignment recommended by Herzberg[5], the bond-lengths and angles given by Crawford[1], and the tables of Pitzer and Gwinn[6]. They are unlikely to be in error by more than 0·15 cal. The results obtained above 120° C. by de Vries and Collins[2] have been corrected by the Berthelot equation and are also included in the diagram.

The experimental results favour the lower (spectroscopic) value for the barrier height. This would indicate that the entropy discrepancy of $1{\cdot}0 \pm 0{\cdot}25$ E.U. is real. Pauling[7] showed that a similar discrepancy of 0·8 E.U. for ice could be accounted for by assuming a 'residual entropy' at low temperatures due to a completely random orientation of hydrogen bonds. Methanol may be similar. Unfortunately, the crystal structure is not known; but an infinite lattice with every oxygen atom tetrahedrally co-ordinated to one methyl group (covalency) and three other oxygen atoms (H-bonded) would allow each molecule to arrange its OH bond in three equivalent directions. The chance that its neighbours would permit any given orientation is 2/3. In *complete* disorder, such a lattice would have a residual entropy of $k.\ln 2^N = 1{\cdot}37$ E.U., which is adequate to account for the observed discrepancy. The lattice assumed is in agreement with the X-ray diffraction data for the liquid at − 75° C. [8].

It is interesting that there is a disagreement about the barrier height for methylamine[9], which might have a similarly disordered solid structure, but not for trimethylamine[10], where hydrogen bonding is impossible.

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Factorial Analysis of Rheological Measurements on Cheese

In psychology, the meaning of tests of intelligence and mental abilities has been clarified by factorial analyses of the correlation coefficients between the different tests[1]. In industrial physics there are occasions when empirical tests are employed the exact meaning of which is not fully understood, and where the interrelationships between the tests could profitably be studied by similar means. Subjective judgments of quality as assessed by experts and others may be included. In view of the elusive nature of such subjective judgments in cheese-grading, it has been thought desirable to develop a number of related mechanical measurements.

We have carried out an analysis of six separate mechanical tests directed towards measuring essentially different 'properties' on some 250 Cheddar cheese. The tests were as follows: (1) total penetration of a sphere under standard load into the surface after 30 sec.; (2) percentage of this penetration remaining unrecovered 30 sec. after removing the load; (3) penetration of a cylindrical borer under standard load after 10 sec.; (4) ratio of the 10-sec. reading to the 60-sec. reading of the borer (taken negatively); (5) total penetration of a sphere following a series of increments of load (Meyer analysis); (6) slope of the log deformation/log load curve derived from test 5.

The 58 measurements which were correlated were the means from four samples taken from the same batch of cheese. The correlation matrices from these tests were analysed by Thurstone's Simplified Centroid Method[2] without adjustments to the entries in the diagonal cells in the second stage of approximation. The 'factor axes' may, if desired, be rotated according to specified rules; but in the present analysis of data from experiments not specifically designed for a factorial study, little appeared to be gained by rotation. The correlation and factor matrices are given in the accompanying table.

Correlation matrix: ripe cheese

Test	1	2	3	4	5	6
1	....					
2	0·559	....				
3	0·853	0·674	....			
4	0·636	0·255	0·538	....		
5	0·850	0·544	0·765	0·556	....	
6	0·583	0·094	0·434	0·525	0·390	....

Factor matrix

Test	Factor I	Factor II	Factor III
1	+ 0·957	+ 0·026	− 0·026
2	+ 0·602	− 0·499	+ 0·116
3	+ 0·907	− 0·210	+ 0·164
4	+ 0·677	+ 0·301	− 0·083
5	+ 0·861	− 0·123	− 0·297
6	+ 0·574	+ 0·525	+ 0·101

An analysis of the pattern of factor loadings in relation to the qualitative nature of the tests suggests that factors I, II and III may be termed 'hardness', 'springiness' and 'hardening' respectively. It cannot at present be stated how complex these individual 'factors' are or whether, when additional tests are included, further categories will be necessary. The present analysis agrees with Burt's description of factors as "principles of classification"[3].

It is of interest to note that both the borer test and the ball compressor test, each of which has a high saturation with the first 'factor', have been designed to simulate the actions of the skilled grader, the first when plunging a steel skewer into the cheese and the second when 'thumbing' it[4]. By means of these operations, the grader is able to make useful judgments of the rheological properties of unripe cheese, from which he foretells the development of quality.

We conclude from this preliminary survey that the technique of factorial analysis shows promise of giving valuable information where mechanical properties of complex materials are to be compared and studied.

Acknowledgments are due to the Agricultural Research Council for the grants which have made this work possible.

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LEAD ISOTOPES AND THE AGE OF THE EARTH

By Prof. HAROLD JEFFREYS, F.R.S.

RATIOS of the abundances of isotopes of lead from a considerable number of ores have been given by A. O. Nier[1] and discussed by A. Holmes[2]. They are expressed as numbers of atoms of Pb^{206}, Pb^{207}, Pb^{208} per atom of Pb^{204}. The last is not of radioactive origin; the others are presumably partly original and partly derived from the decay of the radioactive elements U^{238}, U^{235} and Th^{232}. Their abundance would therefore be expected to increase with time, and this is found to be the case; they are more abundant, always relative to Pb^{204}, in ores more recently formed than in old ones. Holmes has used the variation to derive an estimate of the age of the earth, which he gives as about 3,350 million years. This is substantially more than had previously appeared probable, though no evidence definitely contradicts it. On the other hand, several geophysicists have found Holmes's argument difficult to follow; the following account is partly based on a suggestion made privately by Bullard.

We assume that in a region sampled by the extraction of a lead ore from the rocks within it the atomic abundances of U^{238}, U^{235} and Th are u_m, v_m, w_m; then if the age of the crust is t_0 and the decay constants k_1, k_2, k_3, the original abundances were $u_m e^{k_1 t_0}$, $v_m e^{k_2 t_0}$, $w_m e^{k_3 t_0}$. If the actual sample is of age t_m, the amounts surviving when the ore was formed were $u_m e^{k_1 t_m}$ and so on. The losses would be associated with the production of equal numbers of atoms of the corresponding lead isotopes. If the original abundances of the lead isotopes were a, b, c, the abundances in the ores will be x_m, y_m, z_m, where

$$x_m = a + u_m (e^{k_1 t_0} - e^{k_1 t_m}) \qquad (1)$$

with similar relations.

If u_m was constant, equations of this type could lead to no estimate of t_0. By a statistical study we could find the variation of x_m with t_m and hence estimate u_m; but any change in t_0 would produce a change of the right-hand side that could be exactly compensated by a change of a, which is one of the unknowns of the problem. The method would fail if the radioactive elements were uniformly distributed through the crust. But if u_m is variable, there will be variations of x_m even for materials of the same age, and this variation will decrease with increasing age, vanishing for $t_m = t_0$. Hence by study of the scatter of x_m for collections of rocks of different ages, it should be possible to find t_0. Holmes proceeds by taking the ore analyses in sets of four, each of which gives one estimate of t_0, and plots the results on a frequency diagram; but this procedure has two disadvantages. It obscures the essential principle that what matters is the variation with time of the scatter of the data; and it suggests also that the evidence is more abundant than it really is. Holmes determines 1,419 solutions by taking sets of four; but the original data refer to only twenty-five rock samples, so that the same material has been used many times.

The constancy of a, b, c is assumed. Correspondingly we may assume constancy, for a given date, of the ratio u_m/v_m. At present this is 139; but as U^{235} decays more rapidly than U^{238}, the ratio was smaller in the past. I shall give two solutions, one without this assumption and one with it.

Study of the radioactive content of rocks has shown that within a given region the abundance of the radioactive elements follows a Pearson Type III law with terminus at zero; but the formation of the maximum likelihood equations with this law proved to be very complicated in the present problem, and as the data refer to many parts of the world the values of the index for specimens from special regions would not be applicable. The normal law of error will therefore be used.

Of the data quoted by Holmes, two (Nos. 20 and 24) are for ores of unknown age. Three (Nos. 9, 10, 11) are for ores from Joplin, Missouri. In other cases where different specimens from the same place have been analysed, mean values are given, and there seems to be no reason against doing the same for the Joplin leads. The data to be used here are then as follows. Holmes's numbering is retained.

No.	Pb^{206}	Pb^{207}	Pb^{208}	Age (m.y.)	Residuals		
1	18·85	15·66	38·63	25	+0·06	+0·03	+0·16
2	18·67	15·45	38·15	25	−0·12	−0·18	−0·32
3	18·40	15·53	38·1	25	−0·39	−0·10	−0·37
4	19·22	16·17	39·15	25	+0·43	+0·54	+0·68
5	18·07	15·40	38·0	25	−0·72	−0·23	−0·47
6	18·71	15·70	38·5	25	−0·08	+0·07	+0·03
7	19·30	15·73	39·5	60	+0·51	+0·10	+1·03
8	16·04	15·11	35·26	60	−2·75	−0·52	−3·21
9, 10, 11	21·89	15·92	40·93	100	+3·10	+0·29	+2·46
12	17·75	16·21	38·05	175	−0·29	+0·56	+0·10
13	18·10	15·57	37·85	220	+0·06	−0·08	−0·10
14	18·20	15·46	37·7	220	+0·16	−0·19	−0·25
15	17·36	15·46	37·38	220	−0·68	−0·19	−0·57
16	18·46	15·66	38·6	220	+0·42	+0·01	+0·63
17	17·95	15·57	37·9	220	−0·09	−0·08	−0·05
18	18·43	15·61	38·2	220	+0·39	−0·04	+0·25
19	14·65	14·65	34·48	600	−0·81	−0·25	−0·56
21	16·27	15·16	35·60	800	+0·81	+0·26	+0·56
22	16·07	15·40	35·5	1200	+0·09	+0·07	+0·13
23	15·93	15·29	35·25	1200	−0·05	−0·04	−0·10
25	15·93	15·30	35·3	1330	−0·05	−0·03	−0·05

The ages fall into four groups, for which the summaries are as follows:

Mean age	Pb^{206}		Pb^{207}		Pb^{208}		Number
	Mean	s_1	Mean	s_2	Mean	s_3	
41	18·79	1·52	15·63	0·30	38·47	1·52	9
214	18·04	0·39	15·65	0·26	37·95	0·38	7
700	15·46	1·15	14·90	0·36	35·04	0·79	2
1243	15·98	0·081	15·33	0·061	35·35	0·132	3

The residuals are given in detail, as it will be necessary to refer to them again. s is the standard deviation of one observation, found from the usual formula.

There is a clear trend in the means, a less clear one in the standard deviations s. The estimate of t_0, as we have seen, will depend wholly on the latter. Now if the standard error of u_m is σ_1, that of x_m is $\sigma_1(e^{k_1 t_0} - e^{k_1 t_m})$, and s_1 is an estimate of this. As the standard error of s_1 itself can be taken as $s_1/\sqrt{\{2(n-1)\}}$, it is convenient to write the equations of condition in the form

$$\log \sigma_1 + \log(e^{k_1 t_0} - e^{k_1 t_m}) = \log s_1 \pm \frac{1}{\sqrt{\{2(n-1)\}}}. \qquad (2)$$

For each t_m we have such an equation, and σ_1 is independent of t_m. The equations can be solved by the method of least squares. The solutions are as follows. The last expression in each case has an uncertainty independent of that of t_0: $\beta = (t_0 - 1{,}600 \text{ m.y.})/100 \text{ m.y.}$

$$\left.\begin{array}{lll} Pb^{206}. & \log \sigma_1 = +1{\cdot}54 \pm 0{\cdot}26; & t_0 = 1{,}250 \pm 170 \text{ m.y.}; \quad \log \sigma_1 + 0{\cdot}113\,\beta = 1{\cdot}14 \pm 0{\cdot}17 \\ Pb^{207}. & \log \sigma_2 = -2{\cdot}25 \pm 0{\cdot}33; & t_0 = 1{,}390 \pm 170 \text{ m.y.}; \quad \log \sigma_2 + 0{\cdot}162\,\beta = -2{\cdot}59 \pm 0{\cdot}17 \\ Pb^{208}. & \log \sigma_3 = +2{\cdot}54 \pm 0{\cdot}26; & t_0 = 1{,}430 \pm 180 \text{ m.y.}; \quad \log \sigma_3 + 0{\cdot}108\,\beta = 2{\cdot}36 \pm 0{\cdot}17 \end{array}\right\}. \qquad (3)$$

We compare these solutions with the separate values of s that they were derived from; using the standard errors suggested by (2) we get respectively $\chi^2 = 11{\cdot}9$, $0{\cdot}9$ and $11{\cdot}3$, in each case on two degrees of freedom. Plainly there is some source of variation besides those contemplated in the hypotheses. Also as the estimates of t_0 are not much more than the age of the oldest ore, the probability distributions of t_0 must be very unsymmetrical.

In addition, we have from direct measurement of the isotopic abundances of U^{238} and U^{235}

$$\log \sigma_1 - \log \sigma_2 = 4{\cdot}93. \quad (4)$$

We take the last two equations for each of Pb^{206} and Pb^{207}, use (4) to eliminate σ_2, and get a least squares solution

$$\beta = -1{\cdot}1 \pm 1{\cdot}2\,;\ t_0 = 1{,}480 \pm 120 \text{ m.y.}\,;\ \log \sigma_1 = 1{\cdot}89 \pm 0{\cdot}21. \quad (5)$$

Comparing this with the four equations used, we get $\chi^2 = 28{\cdot}7$ on two degrees of freedom. Thus we have a still more serious discordance.

None of the solutions is anywhere near that given by Holmes; and in any case it will be necessary to truncate the probability distribution found for t_0, because the most probable values on these data alone are less than the ages of some known rocks. The following procedure, however, is of some interest. If we take $\sigma_1/\sigma_2 = 139$ as before, the ratio of the present amounts of Pb^{206} and Pb^{207} of radioactive origin should be

$$139\,(e^{k_1 t_0} - 1)/(e^{k_2 t_0} - 1). \quad (6)$$

For $t_m = 41$ m.y., the ratio should not differ appreciably from this; and the ratio of the values of s_1, s_2 gives

$$\log s_1 - \log s_2 = \log 5 \pm \frac{1}{2\sqrt{2}}. \quad (7)$$

This expression, equated to (6), gives an equation for t_0, and the solution is

$$t_0 = 4{,}000 \pm 370 \text{ m.y.} \quad (8)$$

This is comparable with Holmes's estimate.

This result, though based on only a portion of the data, indicates the source of the principal discrepancy. When three separate solutions give values in the neighbourhood of 1,400 m.y., a piece of evidence that gives a value differing from this by 2,600 ± 370 m.y. will make a very large contribution to χ^2 however the data are combined. If we accept the smaller values of t_0, or indeed any value less than 3,000 m.y., the variation of Pb^{207} as between ores of the same age is greater than we should expect from the variation of Pb^{206}. On the other hand, if we adopt a value near 4,000 m.y., we have no explanation of the small scatter of the values for the three oldest ores.

The validity of the comparison made in deriving (5) or (8) can be checked from the original residuals. If it is correct that the original ratios of isotopic abundances for the same element were absolutely constant, then for rocks of the same age there should be a strictly linear relation between those of Pb^{206} and Pb^{207}. There are too few determinations in the two oldest groups, but for the two more recent groups we find the following correlation coefficients:

$t_m = 41$ m.y. Pb^{206} and Pb^{207}, $+0{\cdot}77$; Pb^{206} and Pb^{208}, $+0{\cdot}94$.
$t_m = 214$ m.y. Pb^{206} and Pb^{207}, $-0{\cdot}11$; Pb^{206} and Pb^{208}, $+0{\cdot}77$.

On the hypothesis considered, the correlations between the two lighter isotopes should be $+1{\cdot}0$. Actually it appears that the variation of Pb^{206} accounts in the first set for little more than half the variance of Pb^{207}, in the second for none of it. The correlations of Pb^{206} with Pb^{208} in both cases are higher than with Pb^{207}. The two largest residuals, numerically, for Pb^{206} are for ores No. 8 and Nos. 9, 10, 11, and are associated with Pb^{207} residuals of the same sign; but the larger Pb^{207} residual for No. 4 is associated with a much smaller Pb^{206} one. Evidently there is a disturbance affecting the values for Pb^{207} by ± 0·2 or so and not associated with the variation of Pb^{206}. This could be due to a variation of the order of 1 per cent in the isotopic constitution of the primitive lead, or to experimental errors of the same order in the estimates of Pb^{204}. But in any case the existence of such a disturbance, whatever its explanation may be, shows that no reliance can be placed on the estimates of t_0 that depend on the abundance of Pb^{207}.

On the other hand, each of the values found from Pb^{206} and Pb^{208} gives a χ^2 about six times its expectation, and the adopted uncertainty taken from the normal law of error is much too low. If we simply redetermine it from the residuals, we must multiply it by about 2·4. The determinations are not independent, since we have seen that the variations within the groups are closely correlated; the best we can do is simply to average the solutions as they stand and increase the estimated uncertainty. The solution is then

$$t_0 = 1{,}340 \pm 420 \text{ m.y.}$$

Ahrens[3] gives 2,100 m.y. for the ages of the oldest known rocks. This would suggest that the small scatter in the oldest group of ores in the present study is an accidental agreement. As there are only three in this group, this is quite probable. But so far as the present study goes, it suggests that Ahrens's value is not much less than the true age of the crust. To improve the estimate appreciably would require isotopic analyses of at least four times as many old lead ores. The point is that with any statistical treatment of the data there is a great asymmetry of the posterior probability of t_0; corresponding to the possibility that the scatter of the data for the oldest rocks is an over-estimate, there will be a strong concentration of the probability for values between the greatest of these ages and the 'best estimate', but this must be balanced by a long tail on the other side to give the expectation found for the squared error. Additional information such as the discovery of actual rocks of greater ages will then be taken into account by cutting out the part of the probability distribution of t_0 for values less than the ages of these rocks[4].

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EFFECTS UPON TUMOURS OF VARIOUS HALOALKYLARYLAMINES

By Prof. ALEXANDER HADDOW, Prof. G. A. R. KON, F.R.S. AND Dr. W. C. J. ROSS

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In an extension of work upon the growth-inhibitory and carcinogenic effects of 4-aminostilbene[1], special attention has been devoted to the influence on these properties of varying the basic side-chain. In one series, the compound 4-NN-di(2-chloroethyl) aminostilbene was of interest as containing the chloroethyl groupings characteristic of the nitrogen mustards. Administration of this substance in relatively high dosage (*c.* 500 mgm./kgm.) to rats bearing the Walker carcinoma, in an orienting type of experiment already described[1], produced an inhibition of tumour-growth considerable in degree but of very brief duration; and pharmacologically the compound appeared, not surprisingly, to be markedly different from the aliphatic chloroethylamines on one hand and the aminostilbenes on the other.

Partly because of the relatively low toxicity of this compound, and partly because published results in this field deal mainly with chloroalkyl derivatives of aliphatic amines, it became of interest to decide in what types of aromatic amine (if any) the NN-di-2-chloroethyl side-chain could still contribute its specific cytotoxic properties: a long series of haloalkylarylamines, a description of some of which is now in press[2], has therefore been examined to this end. From the biological results it is apparent that marked cytotoxic and inhibitory activity, as judged against the growth of various animal tumours, is a feature of the NN-di-2-chloroethyl derivatives of aniline, *o*-, *m*- and *p*-toluidine, *o*- and *p*-anisidine, β-naphthylamine, and *p*-aminobenzoic acid. Less activity was observed for the corresponding derivatives of α-naphthylamine and *p*-aminobenzaldehyde, while no activity was detected (under the conditions employed) for those of 2:4-dinitroaniline and *p*-xenylamine, or for the NNN'N'-tetra-2-chloroethyl derivatives of benzidine, *o*-tolidine or *o*-dianisidine. Certain compounds, for example, NN-di(2-chloroethyl)-*m*-toluidine and NN-di(2-chloroethyl)-β-naphthylamine, showed perceptible advantages in reduced toxicity, and by administration of these in a single intraperitoneal injection of 70–100 mgm./kgm. in solution in arachis oil on the day following implantation with the Walker tumour, it is possible to extend the survival-period considerably, and even to inhibit development of the graft completely in about half the animals. Similar results may also be obtained through administration of such compounds orally.

In such experiments it has been noted that treated tumours may increase in size for a few days before undergoing regression. Regression is, however, less frequent in larger tumours, although prolongation of survival-time can still be demonstrated in animals bearing fully established tumours. While rather less marked results have been obtained in the case of various mouse neoplasms, for example, spontaneous mammary cancer, the Crocker sarcoma 180, the sarcoma *S*37, the Gorer histiocytoma and a transplantable lymphosarcoma, outstanding sensitivity to inhibition is seen in spontaneous and transmitted leukæmia originating in the Furth *AK*1 pure line, and is expressed in much longer survival times (in certain cases of the order of many weeks) than can be achieved by the treatment of the same tumour with urethane.

Work now in progress is aimed at establishing the optimal structural requirements for biological activity, and correlating such with chemical reactivity. Inhibitory activity is clearly associated with the haloethyl chain and not with the basic nature of a given substance, since diethylaniline, for example, is wholly inactive. As in the aliphatic series, a prominent feature is dependence for activity upon two haloalkyl groups; thus the following types are inactive: N-2-chloroethyl-N-ethylaniline, NN-di(2-cyanoethyl)-aniline, 2-chloroethylphenylsulphide, chloroacetophenone. Substituents in the aromatic ring which reduce the reactivity of the chlorine atoms, as measured by the rate of hydrolysis in aqueous acetone (for example, *p*-NO_2, *p*-Cl, *p*-CHO and *p*-CO_2Et), also reduce the biological activity. The active NN-di(2-chloroethyl)-*p*-aminobenzoic acid is an interesting case since the reactivity of the chlorine atom, while low in the free acid, is appreciably higher in the anion which would be formed at physiological *p*H. A considerable number of 2-bromo- and 2-iodo-homologues has been prepared: replacement of Cl by Br or I leads in general to active compounds which hydrolyse more rapidly than the corresponding chloro derivatives and usually exhibit increased toxicity. Halo-ethylamine derivatives of larger molecules, for example, diphenyl, are less soluble, and substances of this kind may be inactive notwithstanding substantial reactivity of the halogen atoms.

This feature suggests that a certain concentration of reactive halogen compound, expressed as 'reactivity of halogen × solubility', must be reached in order to permit biological activity. Such a relation is shown in the series NN-di(2-chloroethyl)-*p*-xenylamine (inactive), NN-di(2-bromoethyl)-*p*-xenylamine (active), NN-di(2-iodoethyl)-*p*-xenylamine (highly active), and NN-di(2-chloroethyl)-*p*-chloroaniline (inactive), NN-di(2-bromoethyl)-*p*-chloroaniline (active), where in both cases increasing reactivity of the halogen atom compensates for decreased solubility. While 3-chloropropyl derivatives are inactive, as might be anticipated from the low reactivity of the halogen atom, NN-di(3-iodopropyl)aniline is also inactive, although in this case the reactivity of the iodine atoms is as high as that of the chlorine atoms in NN-di(2-chloroethyl)aniline. 2-Chloropropyl derivatives are in general biologically active and tend to show increased toxicity, as would be expected from the high reactivity of the halogen: an interesting comparison is provided by NN-di(2-chloroethyl)-*p*-chloroaniline (inactive) and NN-di(2-chloro-*n*-propyl)-*p*-chloroaniline (active). The 2-chloropropyl derivatives studied are hydrolysed without change of structure (cf. Ross[3]), and in particular no evidence has been obtained to suggest, nor would the form of the hydrolysis curves lead one to postulate, the formation of an ethyleneimonium ion. The low basicity of the chloroalkylarylamines (for example, for NN-di(2-chloroethyl)aniline $pK_a = 2{\cdot}2$ in a series measured by Mr. G. C. L. Goss) would possibly account for the non-existence of this intermediate, in contrast with the higher basicity of the chloroalkylamines (for

example, for methyl di(2-chloroethyl)amine pK_a = 6·1 [4]).

A fuller account, including a description of the cytological effects produced by these compounds in tumour tissue and normal organs, the influence of diet upon response, the further correlation of biological activity with chemical and physical characters, and the clinical effects of selected compounds, will be published later jointly with others. The investigation has been supported by generous grants made to the Royal Cancer Hospital by the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the Division of Research Grants of the U.S. Public Health Service, and was conducted during the tenure by one of the authors (W. C. J. R.) of a Sir Halley Stewart Fellowship. It is a pleasure to acknowledge the assistance provided by Mr. J. L. Everett in the preparation of some of the compounds described.

[1] Haddow, A., Harris, R. J. C., Kon, G. A. R., and Roe, Edna M. F., *Phil. Trans. Roy. Soc.*, A, **241** 147 (1948).
[2] Ross, W. C. J., *J. Chem. Soc.* (in the press).
[3] Ross, S. D., *J. Amer. Chem. Soc.*, **69**, 2982 (1947).
[4] Hanby, W. E., Hartley, G. S., Powell, E. O., and Rydon, H. N., *J. Chem. Soc.*, 519 (1947).

OPHTHALMIC OPTICS

ON November 3, the master of the Worshipful Company of Spectacle Makers, Alderman Sir Frank Newson-Smith, opened a two-day optical convention which was held in the Apothecaries' Company's Hall, London, to mark the fiftieth anniversary of the inauguration of the Company's examinations. During this time, 116 examinations have been held and 4,200 diplomas issued, so that at the present time the services of a useful nucleus of trained opticians is available for the administration of the Health Service Act.

The Spectacle Makers' Company is an old City guild with a charter dating from 1629, which with supplementary ordinances gave control over persons practising the craft throughout Great Britain. These powers were at first rigorously applied; but by the end of the nineteenth century had fallen into disuse. A class of ophthalmic optician had been growing which petitioned the Company about 1898 to associate itself with the training and examination of opticians. The convention just held affords ample evidence that the Company is very much alive, particularly at the present time, to the encouragement of the sciences of spectacle and visual optics.

Papers presented and discussed were: (1) The Need of Research and the Means of Meeting it (A. J. Philpot); (2) Optical Theory and Ophthalmic Lenses (W. Swaine); (3) Nomography Applied to Optical Calculations (A. G. Bennett); (4) Some Applications of the Slit Lamp (H. C. Binstead); (5) Binocular Vision (Lord Charnwood); (6) Binocular Vision (Dr. W. D. Wright); (7) Routines and Techniques (C. S. Flick); (8) The Causes of Faulty Refraction (Prof. H. Hartridge); (9) The Physical Interpretation of the Spectral Sensitivity Curve of the Eye (Dr. W. S. Stiles). It is expected that these papers will be bound together in a commemorative volume.

It may be that the successful convention just held, coinciding as it does with the emergence of a profession attending to the visual requirements of the nation, marks the start of an era in which opticians will take a greater part in scientific advancement. Mr. Philpot pointed out that ophthalmic optics is concerned with a nicely balanced mixture of fundamental and applied study, visual problems and spectacle production. While small firms may not be able to finance a special research worker, it should be possible to engage the services of a scientific worker who through education, background and experience could serve as an interpreter and liaison officer between his own organisation and the external research field. The possibility of co-operative research was emphasized. On the visual side, it may be advisable for the optical community to provide bursaries for postgraduate research workers and to provide machinery to effect the absorption of such within the community.

Prof. L. C. Martin presided over the session devoted to the discussion of optical theory and lens calculations. Mr. Swaine, from his experience as examiner to the Company, urged the more direct application of basic fundamental theory not only by candidates for the examinations but also by those who had qualified. He pointed out that it is possible to write down immediately formulæ, involving successive addition or multiplication only, which describe most of the more complicated actions of accommodation, convergence and retinal image size when the eyes are aided by lenses or instruments. Mr. A. G. Bennett gave a valuable summary of nomographic methods generally and their application to ophthalmic and other lenses. A nomogram to solve the problem of contact lens design was described. Of particular interest was a composite circular and elliptic nomogram—four nomograms on one framework—designed to solve the laborious calculation of prismatic effect at decentred points of astigmatic thin lens systems.

Mr. H. H. Emsley, an examiner to the Company, presided over a session to discuss binocular vision. Lord Charnwood commenced with a review of fusion and suppression theories of stereoscopic vision. With his paper he presented a set of eight stereograms with which self-experimentation could be made in order to test descriptions and deductions which a theory of stereopsis must explain. Some of these are: single binocular vision can obtain provided retinal disparity is not too great, when it will be seen that the images glide into fusion; fusion of disparate images is more difficult if disparity is such as to contradict other clues. Suppression of stereopsis can occur without suppression of images, and occurs when the stereopsis runs counter to preconceived convictions—such suppression causes discomfort. The role of the mind in choosing an interpretation which fits best the other evidence, changing from one interpretation to another at will, was emphasized. An explanation was suggested whereby stereopsis is attained by a process of integration of successive disparities too small to cause physiological diplopia.

Dr. W. D. Wright took up an intentionally provocative thesis criticizing the theory that stereopsis arises from retinal disparity. The rapid drop of visual acuity with distance from the fovea suggests that the peripheral parts of the retina contribute little to stereoscopy from disparate points. It does impart to the eyes a pointer-like action ('visual fingers') by the foveæ which, combined with an elementary foveal fusion and with the assistance of the muscle movements, through mental integration, serves to complete the solidity impression.

Mr. H. C. Binstead showed the development of the slit lamp from Gullstrand through Fincham's design

to its applications for the examination of the iridic angle, depth of the anterior chamber, depth of lesions in the eye media and the ingenious Ronne colloidometer for measuring the albumen content of the aqueous. Mr. C. S. Flick set the question: Do routines and techniques for the measurement of refractive error matter? A set of four typical routines included one which was typically American—a twenty-one point technique with standardized analysis—which led to extensive discussion.

Prof. H. Hartridge provided a fascinating introductory study of the development of X-ray techniques for determining the actual length of the living eye (Rushton, Sorsby and O'Connor) and the Goldmann–Hagen modification for measuring refraction. This led to the development of the main topic of his lecture, the cause of refractive error. Five or six theories were passed under review to explain the normal tendency of eyes so commonly hypermetropic at birth to settle down to an approximate emmetropic condition. The X-ray technique should serve to separate the roles of axial length and of optical refraction, which hitherto was not possible.

Dr. W. S. Stiles reviewed the physics of light absorption (including finer adjustments introduced by quantum considerations) and the bleaching of visual purple. Three curves of corrected means effected a simultaneous comparison of absorption coefficients and photosensitivity of visual purple solutions and the subjective spectral sensitivity of the dark-adapted parafoveal retina. The maxima at 500 mμ all agreed; but further study is needed in order to explain the differences towards the violet side, where there appears an absorption band at about 360 mμ. The curves agree very well on the red side of the maximum, especially as regards linearity and gradient, for which a rough theory giving a good fit of gradient was elaborated. A comparison of spectral sensitivity curves of the parafoveal rod vision and of the foveal cone vision shows, besides the Purkinje shift, a significant gradient difference on the red side of the maximum. This will require explanation in any future photochemical theory of vision.

WILLIAM SWAINE

ELASTICITY OF WOOD AND PLYWOOD

SPECIAL REPORT No. 7, issued by the Forest Products Research Laboratory (London: H.M. Stationery Office, 1948. 2*s*. net), summarizes the available information on a piece of important research undertaken on the "Elasticity of Wood and Plywood". The work and results embodied in the report are said to be mainly for the designer and the research worker. The forest officer might also have been included, since on the work of the sylviculturist all 'wood' of the future, whatsoever its type, may be said to depend, with the exhaustion of Nature's resources.

The theory of wood elasticity rests on the assumption that the gross material possesses three perpendicular planes of elastic symmetry, and that it is perfectly elastic and homogeneous. A point which needs emphasis at the outset is that wood is actually only an approximation to this ideal material. The longitudinal tangential surface (the surface generated by a line parallel to the axis of the tree and moving along the growth rings) is not plane, but roughly cylindrical. The other two principal surfaces, the longitudinal-radial (defined by the axis of the tree and the medullary rays) and the tangential-radial, are more truly plane; but even in these cases there will be some deviation owing to local irregularities in the growth of the tree. This is where the sylviculturist comes in. "The extent to which any actual specimen departs from the ideal material will depend not only on the regularity of the growth but also on the position of the specimen in the tree."

The report is intended chiefly as a summary of knowledge known, but it contains a number of new results, some obtained in America and Australia during the Second World War, here published for the first time. The first part of the report is entitled the "Elastic Constants of Wood"; it deals with the measurement of the nine independent elastic constants of wood and the effect on them of factors such as temperature, moisture content and grain angle. The second part deals with the elastic constants of plywood. The manner in which they are related to the form of construction of the plywood and to the elastic constants of the wood from which the plywood is made is explained.

Under the heading of "The Properties of Plywood Plates and Cylinders", the third part deals with the frequency of vibration, the buckling and deflexion of plywood plates and the buckling of plywood cylinders.

INTERNATIONAL SCIENTIFIC FILM ASSOCIATION

SECOND ANNUAL CONGRESS

THE most important outcome of the annual congress of the International Scientific Film Association held in London during October 4–11, 1948, has been the formation of a number of international commissions to pursue in detail the programme of work agreed in general by the member countries for the coming year. Before discussing this programme, a few words on the Association's history may not be out of place.

The International Scientific Film Association was inaugurated last year in Paris, largely as a direct result of the initiative of the British and French Scientific Film Associations. The preliminary work of these two organisations, the first contact of which at the end of the War revealed many common interests, resulted in the assembly last year of representatives from twenty-two countries to discuss and agree to the formation of this international organisation to further the interests of the scientific film. Unesco, recognizing the scientific film as an important aid in the dissemination of knowledge, showed a benevolent interest in the new Association, the maintenance of which was demonstrated by the attendance again of a Unesco observer at this year's Congress.

Some twenty-five countries had accepted the invitation to the second Congress, and the number of those who finally managed to send delegates fell little short of this figure, some unfortunately failing to overcome the many obstacles with which post-war travelling is beset.

The honour of organising this year's congress was given to Great Britain, and its Scientific Film Association, assisted by financial aid from the British Film Institute, rose worthily to the occasion. A very

full programme of eight days of meetings, receptions, demonstrations and film showings was arranged and carried through smoothly.

The general assemblies of the delegates formed the most important part of the proceedings. The events of the first year of the Association's history were reviewed, and delegates gave brief reports of the work being done in their countries. It was striking testimony to the value of the activities of the Scientific Film Association of Great Britain to note how several countries, notably Holland and Belgium, are modelling their own young organisations along closely similar lines.

The need for continuous exchange of general information, and details regarding films in particular, soon established itself as paramount in the discussions. A vital step in its fulfilment was taken by the approval of an index card to record essential data of scientific films and thus to form the material for the first catalogue of such films available throughout the world. One of the international commissions set up was charged with supervising this work and preparing recommendations for the international appraisal and grading, according to merit and purpose, of scientific films.

Other matters of prime interest in the further work of the Association were also entrusted to commissions. It is believed that these will be able to work out practical details for some kind of international co-operation in the joint production of certain specialized films, and that eventually the problem of film distribution on the widest international scale will be solved. Discussion indicated to what extent customs barriers and finance regulations are likely to hinder the early achievement of this aim, but hope for a solution, even if only on a limited scale at present, was not abandoned.

The Belgian delegate offered a very practical contribution by trying to form an international scientific film reference library in his country. The representative of the Dominican Republic suggested that they might help by providing translations of information for the Spanish-speaking countries. Such offers of practical assistance showed the keen interest in the proposed activities and pervaded the meetings with a strong feeling that the aims of this international organisation are likely to be successfully implemented.

Much of the proceedings of the assemblies was in connexion with the constitution and internal organisation of the Association itself. While these may not be of such immediate public appeal as other matters already mentioned, they are none the less essential for the smooth and efficient working of the Association. In accordance with its democratic constitution, delegates from member countries elected a governing Council for the coming year, the officers of which are: *President:* M. Jean Korngold (Poland); *Vice-Presidents:* Mr. John Maddison (Great Britain) and Mr. C. A. Burmester (Australia); *Honorary Secretary:* M. Jean Painlevé (France); *Honorary Treasurer:* M. Luc Haesaerts (Belgium).

In conclusion, mention should be made of some of the many events occupying the full programme of the week. Receptions for the delegates were given by the Council and Congress Committee of the Scientific Film Association of Great Britain, the Royal Microscopical Society and the British Council. At the former, the inaugural reception, delegates were received by the Parliamentary Under-Secretary of State for Commonwealth Relations on behalf of the Lord President of the Council. These various functions, while dignified, were given a pleasantly informal character by the renewing of many old friendships among the delegates.

The Scientific Film Association of Great Britain had also organised some specialists' meetings dealing with the film in medicine, schools, universities, industry and scientific research. They provided welcome opportunities for discussion between experts in Britain and abroad as to how best the film can help in these various fields. Much valuable material was contributed from both sides and the detailed discussions served to co-ordinate thought on these problems. These links between groups of similar specialized interests, thus established, will serve to strengthen considerably the work of the International Association.

Fifteen of the participating countries sent more than sixty scientific films, some of which were shown during the course of these specialized meetings, but about forty of which formed the programme for a public International Scientific Film Festival held in London on October 8, 9 and 10. Such was the interest in this Festival that the hall of the Royal Empire Society was filled to capacity by some four hundred spectators on six separate occasions. An even wider audience, estimated at 100,000, was reached, however, by means of television. On October 4, a special programme was transmitted giving previews of some of the films to be shown later and ending with the first demonstration in Britain by the French delegate, M. Jean Painlevé, of the combination of television camera and microscope to achieve 'live' broadcast pictures of microscopic organisms.

The second congress of the International Scientific Film Association in London will undoubtedly be remembered as a significant milestone in the history of the Association. One may hope, however, that it served an even wider purpose, for it demonstrated once again the common aim of all men of science to further human progress and happiness. To achieve this on a truly world-wide scale, the film will play a major part by using visual images to transcend barriers of language in the spreading of knowledge.

MICHAEL MICHAELIS

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, November 20

ROYAL AERONAUTICAL SOCIETY (joint meeting with the HELICOPTER ASSOCIATION, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Discussion on "Helicopters".

Monday, November 22

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Single-Phase to Three-Phase Conversion Systems" (to be opened by Mr. A. N. D. Kerr).

UNIVERSITY OF LONDON (at the Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. H. E. Bowman: "Education for International Understanding—The Moslem World".*

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER AND DISTRICT SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. W. McG. Morgan: "Accelerators for Stocks containing Reinforcing Furnace Blacks".

TEXTILE INSTITUTE, YORKSHIRE SECTION (in the Large Hall, Technical College, Huddersfield), at 7.15 p.m.—Mr. B. H. Wilsdon: "Principles of Textile Research".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. L. H. Bedford: "Some Technical Aspects of Television" (Cantor Lecture).

Tuesday, November 23

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. F. W. Jane: "Some Problems in being a Tree".*

CHADWICK PUBLIC LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. Alister MacDonald: "The Influence of Hygiene on the Shape of Buildings" (Bossom Gift Lecture).*

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Robert H. Lowie: "Some Aspects of Political Organisation among the American Aborigines" (Huxley Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. E. Rhys-Jones: "Printed Circuits, including Miniature Components and Sub-Miniature Valves".

SIR HALLEY STEWART TRUST LECTURE (at the Memorial Hall, Farringdon Street, London, E.C.4), at 6 p.m.—Lord Russell, F.R.S.: "The Atomic Age—Our Scale of Values in the Atomic Age".*

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at the St. Enoch Hotel, Glasgow), at 7 p.m.—Dr. D. Traill: "The Problem of the Synthetic Fibre".

Wednesday, November 24

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. J. E. O'Breen: "Automatic Control of Steam Raising Plant".

UNIVERSITY OF LONDON (at Bedford College for Women, Regent's Park, London, N.W.1), at 5.15 p.m.—Prof. L. J. Audus: "Jungle Economy" (Inaugural Lecture).*

LINNEAN SOCIETY OF LONDON (in conjunction with the SYSTEMATICS ASSOCIATION, at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. T. A. Sprague: "Botanical Taxonomy up to and including Linnæus".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, 57 Mosley Street, Manchester), at 5.30 p.m.—Dr. Metcalfe Brown: "Chemistry and Public Health".*

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL OF THE FOOD GROUP (in No. 3 Room, Gas Industries House, Grosvenor Place, London, S.W.1), at 6.15 p.m.—Dr. J. B. Firth: "Spontaneous Combustion in Hay, Cotton and other Vegetable Materials".

Thursday, November 25

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Discussion on "The Theory and Practice of New Techniques in Separation and Purification".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Small Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Mr. R. S. Dadson and Mr. E. G. Butcher: "Apparatus for Acoustical Measurements at Low Frequencies".

PHYSICAL SOCIETY, LOW-TEMPERATURE GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Prof. C. J. Gorter (Leyden): "Irreversible Processes in Liquid Helium II".

INSTITUTE OF WELDING (joint meeting with the INSTITUTION OF STRUCTURAL ENGINEERS, at 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. H. Gottfeldt: "Curved Bridges and Why they should be Welded".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. W. H. Lindsey: "Development of the Armstrong Siddeley Mamba Engine".

INSTITUTE OF METALS, BIRMINGHAM SECTION (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 6.30 p.m.—Mr. T. Land: "High Temperature Measurements".

ROYAL INSTITUTE OF CHEMISTRY (at the Medway Technical College, Gardiner Street, Gillingham), at 7.15 p.m.—Dr. F. Wormell: "The Corrosion of Metals".

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. E. A. Krahenbuhl: "New Principles in the Continuous Dyeing of Wool".

Wednesday, November 24—Thursday, November 25

INSTITUTION OF GAS ENGINEERS (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 10 a.m. each day.—Fourteenth Autumn Research Meeting.

Friday, November 26

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion.

ROYAL STATISTICAL SOCIETY, BIRMINGHAM GROUP of the INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. Philip Lyle: "Factorial Regression Analysis".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL GROUP (at the Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.45 p.m.—Mr. W. T. Hale: "The Statistical Solution of an Industrial Problem".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. A. B. D. Cassie: "Physics in the Wool Industry".

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (at the Gas Showrooms, Town Hall, Manchester), at 7 p.m.—Mr. P. A. Cummins: "Electronic Equipment for Radio Control".

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (joint meeting with the INDUSTRIAL RADIOLOGY GROUP of the INSTITUTE OF PHYSICS, at 16 Princes Gate, London, S.W.7), at 7 p.m.—Mr. H. S. Tasker and Mr. K. H. Gaseltine: "The Reproduction of Radiographs".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Dr. F. Bergel: "Some Aspects of the Relationship between Chemical Constitution and Physiological Activity".

Saturday, November 27

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 8 p.m.—Prof. T. H. Pear: "Social Stratification as a Necessary Consideration in English Social Research".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATES IN CHEMISTRY (2) as Research Assistants in the Department of Chemical Engineering and Applied Physical Chemistry—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7 (November 27).

LECTURER (Grade IIb) and a LECTURER (Grade IIc) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 1 (November 27).

SCIENTIFIC EDITOR in London (Central Office of Information) for news and feature periodicals published in Eastern Europe—The Ministry of Labour and National Service, Technical and Scientific Register K, York House, Kingsway, London, W.C.2, quoting A.374/48A (November 30).

MINING CONSULTANT to advise the Government of Tanganyika on all matters pertaining to mining development in that territory—The Ministry of Labour and National Service, Technical and Scientific Register K, York House, Kingsway, London, W.C.2, quoting C.731/48A (November 30).

TECHNICIAN IN THE PATHOLOGY AND BACTERIOLOGY LABORATORY at Galway Central Hospital—The Secretary, Galway County Council, County Buildings, Galway (December 7).

CHAIR OF PHYSICAL GEOGRAPHY at Fouad I University—The Dean of the Faculty of Arts, Giza, Egypt (December 15).

LECTURER IN PHYSIOLOGY in the United College—The Secretary, The University, St. Andrews (December 15).

CITY AND WATER ENGINEER to the City of Port Elizabeth, South Africa—Davis and Soper, Ltd., 52–54 St. Mary Axe, London, E.C.3 (December 31).

MARINE ZOOLOGISTS (2)—The Secretary, Marine Biological Association, The Laboratory, Citadel Hill, Plymouth (January 31).

BIOCHEMIST or ORGANIC CHEMIST IN THE DEPARTMENT OF LACTATIONAL PHYSIOLOGY, to assist in the investigations of the intermediary metabolism of the mammary gland—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

TELECOMMUNICATION ENGINEERS in the Postmaster-General's Department, Commonwealth of Australia—The Representative of the Australian Post Office, Australia House, Strand, London, W.C.2, endorsed 'Application for position of Telecommunication Engineer'.

GRADUATES IN PHYSICS or CHEMISTRY for investigation of various problems connected with the manufacture of pottery—The Director, British Ceramic Research Association, Queen's Road, Penkhull, Stoke-on-Trent.

ENTOMOLOGIST in the Medical Department (Health Branch) of the Gold Coast—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

LECTURER IN AGRICULTURAL ZOOLOGY, and an ASSISTANT LECTURER IN AGRICULTURAL BOTANY—The Secretary and Bursar, Seale-Hayne Agricultural College, Newton Abbot, Devon.

DEPARTMENTAL DEMONSTRATOR IN PHYSICAL ANTHROPOLOGY—The Professor, Department of Human Anatomy, The University, Oxford.

PHYSICIST for fundamental work on the structure and properties of fibrous materials, etc., and a PHYSICIST for laboratory and service test of shoes and shoe materials, etc.—The Director, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering.

METALLOGRAPHER with wide experience of non-ferrous metals and alloys, to take charge of metallographic laboratory—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

LABORATORY STEWARD (Grade I) to take charge in Department of Geography—The Registrar, University College, Leicester.

BIOCHEMIST (man or woman, preferably with post-graduate experience in the field of Enzymes or Tissue-Metabolism) for research appointment—The Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1.

TECHNICAL OFFICERS and SENIOR TECHNICAL OFFICERS for work in connexion with the pottery industry—The Director, British Ceramic Research Association, Queen's Road, Penkhull, Stoke-on-Trent.

CURATOR—The Honorary Secretary, Hancock Museum, Newcastle-upon-Tyne 2.

LECTURER IN ZOOLOGY—The Registrar, University College, Exeter.

AGRICULTURAL RESEARCH OFFICER, Cyprus—The Director of Recruitment (Colonial Service), Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Survey and Policy of Field Research in the Archaeology of Great Britain. 1: The Prehistoric and Early Historic Ages to the Seventh Century A.D. Pp. 120. (London: Council for British Archaeology, Institute of Archaeology in the University of London, 1948.) 5s. [48